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**USER'S GUIDE FOR COMBIMAN
PROGRAMS (COMPUTERIZED
BIOMECHANICAL MAN-MODEL) (U)**

VERSION 8

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FOR THE COMMANDER



CHARLES BATES, JR.

Director, Human Engineering Division
Armstrong Aerospace Medical Research Laboratory

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SUMMARY

This User's Guide describes the procedures to operate the Harry G. Armstrong Aerospace Medical Research Laboratory's (AAMRL) COMputerized BIomechanical MAN-model (COMBIMAN) system of programs. Sections 1 through 8 are concerned with a general introduction and specific instructions to use the functions of COMBIMAN. The appendices provide information concerning the data bases used in generating the man-model and crew stations, and operating instructions for the utility programs used in creating and maintaining anthropometric surveys, crew station configuration and vision overlay data bases, and the CADAM to COMBIMAN conversion program. Specific instructions are also included to operate the off-line plot (CBMOFF) and CADAM to COMBIMAN (CADCBM) conversion programs.

Descriptions of the processing capabilities; definitions and examples of input and output data formats; procedures to execute the programs; and explanations of diagnostic messages generated are included for the main programs.

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PREFACE

This work was performed under USAF Contract F33615-84-C-0519, titled "Techniques for Workplace and Maintenance". The government work unit number for this contract is 71840841. The project monitor is Dr. J.W. McDaniel, of the Harry G. Armstrong Aerospace Medical research Laboratory's Workload Ergonomics Branch (AAMRL/HEG). The UDRI technical report number is UDR-TR-89-12.

This report is designed to provide a detailed guide for the use of the computer programs of AAMRL's COMBIMAN system. It gives some background on the data bases but does not document the theoretical approach used in developing the computer programs. The manipulation of the man-model and crew station is straightforward and with the information in Sections 1 through 8 a non-computer person can run the interactive program. Due to the technical nature of Appendices A through E, the personnel assigned to interpret and use these programs should have experience in computer programming.

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GLOSSARY OF TERMS

CADAM	(Computer-graphics Aided Design And Manufacturing) A registered trademark of CADAM, Inc., 1935 N. Buena Vista St., Burbank, CA 91504. CADAM is a CAD/CAM system of programs. Use of this trademark does not constitute an endorsement of the system.
CADCBM	A CADAM to COMBIMAN conversion program (See Appendix E).
CBMAM	The COMBIMAN Anthropometric Data Base Maintenance Program (See Appendix A).
CBMCM	The COMBIMAN Crew Station Data Base Maintenance Program (See Appendix B).
CBMOM	The COMBIMAN Vision Limit Overlay Data Base Maintenance Program (See Appendix C).
CBMOFF	The COMBIMAN Off-Line Plot Program (See Appendix D).
Length related variable	A variable used to define the skeletal system of the COMBIMAN man-model.
Mass related variable	A variable used to define the amount of enfleshment on the COMBIMAN man-model skeletal system.
Nonperspective view	A view in which objects are the same size regardless of the distance from the view.
Panel(s)	Segment(s) of the crew station, used by program to graphically display the crew station.
"OPEN" panel(s)	Panel(s) of one to 25 vertices, with the first and last vertices unconnected.
"CLOSED" panel(s)	Panels of three to 25 vertices, with the first and last vertices connected.
"SEAT" panel(s)	Panel(s) which retain their relationship to each other when moved from one position to another with the Seat Adjust function.
"PEDAL" panel(s)	Panel(s) used to designate a rudder/brake pedal in the program. The program internally uses this

GLOSSARY OF TERMS (CONTINUED)

	designation to properly position the foot on the rudder/brake pedal in those analysis functions (Reach and Strength) which automatically position the foot.
Perspective view	A view which shows the crew station and man-model with infinite perspective. In such a view farther objects appear smaller than closer objects.
PROMPT	A message displayed on the CRT indicating an action is required by the user; e.g., a selection, an entry from the ANKB, positioning the cursor, or, depressing a key on the PFK.
Screen	The display, or cathode ray tube, of a computer or terminal.
Select	Used to notify that the user is to make an on-screen selection using a 'light-pen', 'mouse' or whatever device his particular computer system uses to make on-screen selections.

LIST OF ABBREVIATIONS

AAMRL	Harry G. Armstrong Aerospace Medical Research Laboratory
ANKB	Alpha Numeric Keyboard
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
<CR>	Carriage Return (on some keyboards may be RETURN, ENTER, etc.)
CRT	Cathode Ray Tube
COMBIMAN	<u>COM</u> puterized <u>BI</u> omechanical <u>MAN</u> -Model
JCL	Job Control Language
NSRP	Neutral Seat Reference Point
PFK	Programmable Function Keyboard
PFK #	Program Function Key designated by the number
SRP	Seat Reference Point
UDRI	University of Dayton Research Institute

SECTION 1

INTRODUCTION

During the design and analysis phases of crew station development, it is essential to assess the capabilities, inadequacies, and dangers of the crew station environment with respect to the human operator. The conventional method for accomplishing this has been to build mock-ups and to use an undetermined number of "representative" test pilots to evaluate the work environment and control placement. The mock-ups tend to be costly and time consuming to build, as well as somewhat inflexible during testing. The sample size of the "representative" pilots depends on the availability of pilots and the whims of the designers.

The COMputerized BIomechanical MAN-model (COMBIMAN) system of programs was developed to assist in the design and analysis phases of crew station development. As an interactive-computer-graphics assisted engineering tool, that represents geometric and physical properties of an operator in a crew station, it can be used to evaluate both existing and conceptual crew stations. The COMBIMAN is a three-dimensional man-model existing in computer storage. The crew stations also exist in three-dimensions in computer storage. Since the man-model, in variable body size, and the crew station can be displayed together on a Cathode Ray Tube (CRT), alternative designs may be thoroughly evaluated, without the delays and expense of building and modifying mockups, and across the spectrum of a population's physical geometry. Thus, alternative designs may be thoroughly evaluated, and perma-

nently recorded by hard copy plot or a listing of the crew station and man-model data, (McDaniel, 1976) or by saving data to the COMBIMAN data bases.

1.1 COMBIMAN PROGRAMS

The supplied tape has two versions of the COMBIMAN program: CBM08 and CBM08NOPL; and five utility programs: three data base creation/maintenance programs, CBMAM, CBMCM2 and CBMODM; an off-line plot program, CBMOFF; and a CADAM interface program CADCBM.

COMBIMAN is written mostly in FORTRAN, using the IBM FORTRAN G compiler and some assembler programs assembled under the IBM F Assembler. All graphics are performed using the IBM Graphic Subroutine Package (GSP) to drive either GPS(GAM) or GAM/SP R2 on the user's system. The Versatec VERSAPLOT-07 software plot package is used for ON-LINE plotting. All programs in COMBIMAN use the standard IBM FORTRAN G calling conventions described in Appendix C of IBM FORTRAN IV (G & H) programmers' guide and the standard IBM assembler instruction sets described in the IBM Principles of Operation manual. All routines are non-reentrant.

The FORTRAN G or H compiler is required for any FORTRAN compilations done by the user. The linkage editor is used to load the IBM Graphic Subroutine Package (GSP) into COMBIMAN. Any user defined routines, such as new plot routines, which are linked into COMBIMAN must use the same calling conventions as FORTRAN G and H to properly function.

The IBM/370 instruction set is described in the Principles of Operation Manual (GA22-7000). All error handling for COMBIMAN is done using the standard GSP and FORTRAN error recovery procedures.

REFERENCES:

Principles of Operation	IBM # GA22-7000
FORTRAN IV Language Reference Manual	IBM # GC28-6515
FORTRAN IV (G & H) Programmers Guide	IBM # GC28-6817
Graphics Subroutine Package for FORTRAN IV	IBM # GC27-6973
Linkage Editor & Loader	IBM # GC26-3813

The main program in the COMBIMAN system is the interactive computer graphics program CBM08, which allows the user to generate a variable sized man-model and assess its interaction with crew stations. Files for anthropometric data bases, crew station data bases and visibility limit overlay data bases, other than those supplied with the distribution tape, must be created by the user. The user can create such files with the Anthropometric Data Base Maintenance (CBMAM), COMBIMAN Crew Station Data Base Maintenance (CBMCM2) and COMBIMAN Vision Limit Overlay Data Base Maintenance (CBMODM) programs (See Appendices A, B, and C). The Initialization data set (Figure 1.1) contains data used to construct the man-model, and cannot be changed by the user.

1.2 SYSTEM REQUIREMENTS

The computer used to develop COMBIMAN is an IBM 3031 with four megabytes of real memory running under MVS with TSO. The system uses STC 3650 disk drives (IBM 3350 equivalent), Adage 4370 (IBM 3250 equivalent) display units, an IBM 3203 printer, STC 4500 tape drives, and a Versatec 8222A 22 inch plotter. The

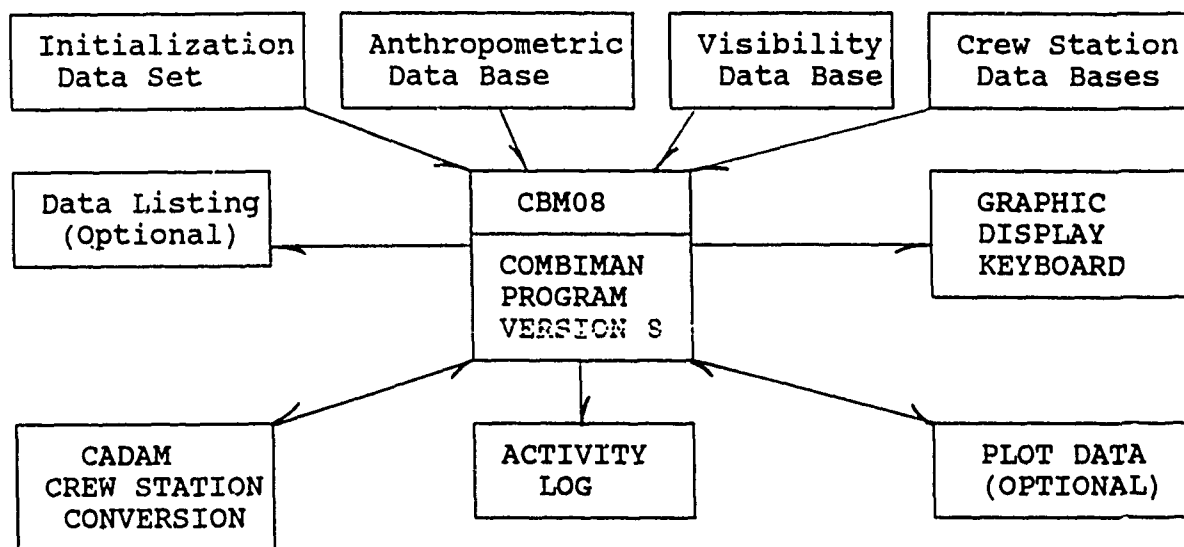


Figure 1.1. Data Flow In the COMBIMAN Program CBM08

IBM 2250 graphic buffer control area requires a minimum of 20K bytes. The minimum amount of real or virtual memory required to run COMBIMAN is 1300K (Figure 1.2).

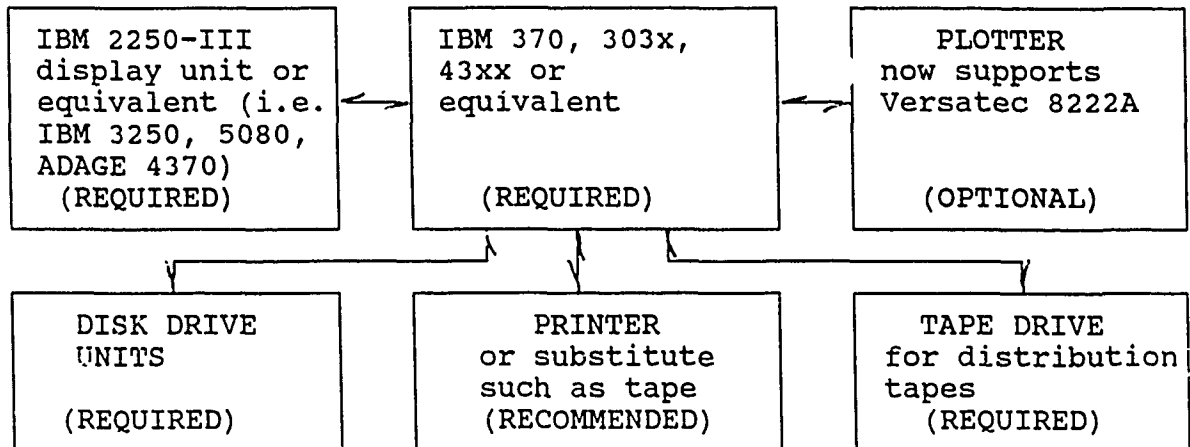


Figure 1.2. Diagram of Required and Optional Hardware.

The COMBIMAN program is designed to run on the IBM system/370, 303x, 43xx, or equivalent computer; executing under OS, OS/VS, MVT, and MVS operating systems. The program also requires an IBM 2250-III or equivalent display unit (IBM 3250 or 5080, or ADAGE 4370); disk unit(s); and nine track, 1600 BPI tape drive to read the distribution tape. A plotter is optional, but recommended, as without it all visual inspection of displays must be done on screen. COMBIMAN generates print output and a printer output device is highly recommended. Print output may be directed to other storage, such as tape or disk, and be recalled for on screen display.

1.3 FUNCTIONS OF COMBIMAN

The functions of COMBIMAN are divided into six basic categories (Figure 1.3). The functions are not separate entities in using the COMBIMAN system; they are interactive and interdependent.

Anthropometry Related functions are used to define the body size, make necessary changes to the angles and dimensions of the internal links and to display the selected, or computed, values for the 12 anthropometric variables used in creating the man-model. These functions are used to manipulate the geometry of the man-model to achieve the desired man-model configuration.

Crew Station Related functions are provided for the user to retrieve existing crew station configurations from the Crew Station Data Base. Once retrieved, the displayed crew station can be modified by deleting and adding elements. These modifications can be temporary or permanent as desired. It is possible, though somewhat impractical, to start from the beginning of the design sequence and create a new crew station configuration using these functions.

Display Related functions allow the user to manipulate the on-screen presentation in the display area of the CRT. With these functions the user can rotate and magnify the presentation in the display area. Objects within the display area can be identified, omitted, and once omitted be included in the display again. Printer-Plotter Related functions supply the hard copy

Anthropometry Related

Define Body Size
Display Link Table
Display Anthropometric Table

Display Related

Change View
Zoom
Increment Roll, Pitch
and Yaw Angles
Identify Panel
Omit Panel
Include Panel

Printer-Plotter Related

Off-Line Plot
On-Line Plot
Print Data

Crew Station Related

Retrieve Crew Station
Seat Adjust
Delete Panel
Design Panel
Save Current Crew Station

Task Analysis Related

Perform Reach Analysis
Reach Curve Analysis
Strength Analysis
Visibility Analysis
Reset Slumped Posture
Reset Erect Posture
Reset Programmed Posture

Program Execution Related

State Switch
Restart Program
End Program

Figure 1.3. Functions Available to COMBIMAN Users

output of the configuration of either the man-model or the crew station. Plot output is generated as soon as a plot function is activated, but the printer output occurs at the end of the run.

Task Analysis Related functions are the heart of the program as they are used to assess the interaction of the man-model with the crew station. The previously listed categories of COMBIMAN functions are used to ready the system for the assessment of the man-machine interaction and to provide the user printouts and/or plots of the information used, or developed, during the analysis.

Program-Execution Related functions permit the user to restart the program, end it, and set State Switches to select variations in the operation of the COMBIMAN program.

1.4 CHANGES AND ADDED CAPABILITIES IN VERSION 8

There have been changes made in the operation of some COMBIMAN functions and two capabilities have been added. Synopses of the changes and additions follow.

1.4.1 Define Body Size Function (PFK 4)

The name has been changed from "Retrieve Anthropometry" to "Define Body Size". Former PFKs 12 (Input 12 Anthropometric Dimensions) and 13 (Input Two Independent Variables) have been de-activated and these functions included as options under PFK 4 (Define Body Size).

1.4.2 Omit Panel Function (PFK 2)

The name of the function has been changed from "Omit Object" to "Omit Panel". This was done as man-model elements can no longer be omitted. Only crew station panels may be omitted. There are four other significant changes to the operation of the function.

- (A) Prior to this version, if more than one panel was to be omitted, the function had to be selected and executed for each individual panel to be omitted. Currently, more than one panel may be selected for omission without having to reselect the function.
- (B) Previously, if the user desired to work with only a few panels in the crew station, he had to individually omit all other panels. In the current version all panels in the crew station may be omitted at once, and the desired panels redisplayed with the Include Panel function (PFK 3).
- (C) Prior versions required the user to write down the reference number of omitted panels so that they might later be redisplayed with the Include Panel function. This is no longer required as the program keeps track of the panels that were omitted.
- (D) In previous versions, if the user wanted to change the view, e.g., from side to front, after the panel(s) were omitted, the crew station was regenerated with all panels included. If the user wished to view from this different perspective with the panels omitted, he had to omit the panels again. In the current version the omitted panel(s) remain omitted from the display until redisplayed with the Include Panel function (PFK 3) or by regenerating the complete crew station with the Retrieve Crew Station function (PFK 5).

1.4.3 Include Panel Function (PFK 3)

In previous versions the user was required to enter the reference number for each omitted panel on the ANKB to redisplay the panel(s) with the Include Panel function. The current version displays only the omitted panel(s) when the Include Panel

function is selected. The user makes an on screen selection of the panel(s) to be redisplayed. The omitted panel(s) may be included individually or all at once.

1.4.4 Delete Panel Function (PFK 18)

Previous versions of the function required the user to know, and enter, the eight character name for the panel(s) to be deleted. With the current version the user makes an on screen selection of the panel(s) to be deleted.

1.4.5 Save Current Crew Station Function (PFK 10)

This function allows the user to save the crew station, in its current configuration, to the Crew Station Data Base. There were two primary reasons for adding this capability. First, it simplifies the procedure for adding modified, or new, crew stations to the Crew Station Data Base by direct input instead of coding data cards for each panel of the crew station. Second, if the user must prematurely end the session, by saving the current crew station configuration, it may be directly recalled when the session is reinitiated, rather than having to recreate the configuration.

1.4.6 State Switch Function (PFK 29)

The format of the State Switch function (PFK 29) has been changed. State switches have been renumbered consecutively, 1 through 10. All state switches act as toggle switches for variations in the operation of the COMBIMAN program. Three

subfunctions have been added. Subfunctions are infrequently used functions. Unlike state switches, subfunctions require user input other than selecting the ON/OFF status.

1.4.7 Crew Data Base Maintenance Program (CBMCM2)

Previous versions of the COMBIMAN programs had two versions of the Crew Station Data Base Maintenance program, CBMCM and CBMCM2. In CBMCM the minimum number of vertices for a panel was 3, while in CBMCM2 the minimum is 1. CBMCM2 also allows a larger number of panels and vertices in the crew station member. In this and future versions, only CBMCM2 will be used for generating and maintaining crew station data base members. Crew station data base members previously installed under CBMCM can be used with this version of the COMBIMAN programs.

1.4.8 CADAM to COMBIMAN Conversion Program (CADCBM)

CADCBM was developed to provide users the capability to directly convert CADAM® 3-D drawing files to COMBIMAN Crew Station Data Base Maintenance input files. This program negates the requirement to code data cards for each panel of the crew station. The directions for its use are in Appendix E.

CADAM® (Computer-graphics Aided Design And Manufacturing) is a registered trademark of CADAM, Inc., 1935 N Buena Vista St., Burbank, CA 91504, and is a CAD/CAM system. Providing this capability does not constitute an endorsement of the CADAM system by the US Air Force or the University of Dayton.

SECTION 2

GETTING STARTED WITH COMBIMAN

With the required software listed in paragraph 1.1, the distribution tape you received has everything to run COMBIMAN, with the exception of the Program Function Keyboard (PFK) overlay. The overlay in Figure 2.1 is full sized and may be photo-copied. The 12 inch square CRT screen is partitioned into Prompting, Information and Display areas as shown in Figure 2.2. Figure 2.3 shows the COMBIMAN display on an ADAGE 4370 CRT. The user's left hand is on the PFK and his right hand is using the light-pen to identify a point on the screen. The Alphanumeric Keyboard (ANKB) is shown below the CRT.

Appendix F contains the installation procedures and Job Control Language (JCL) for the COMBIMAN system of programs. These procedures and JCL modifications for your hardware require a thorough knowledge of your particular hardware configuration and operating system. Your system programmer personnel should install COMBIMAN and make the necessary JCL modifications.

Once installation is complete, COMBIMAN can be executed by submitting either 'COMBIMAN.CNTL(CBM08)', or 'COMBIMAN.CNTL(CBM08NOPL)'. CBM08 is used only on those computer systems which have an on-line plotter. CBM08NOPL is for use on systems which do not have an on-line plot capability. Your system programmer should be able to tell you which to use if there is a question.

COMBIMAN VERSION 8

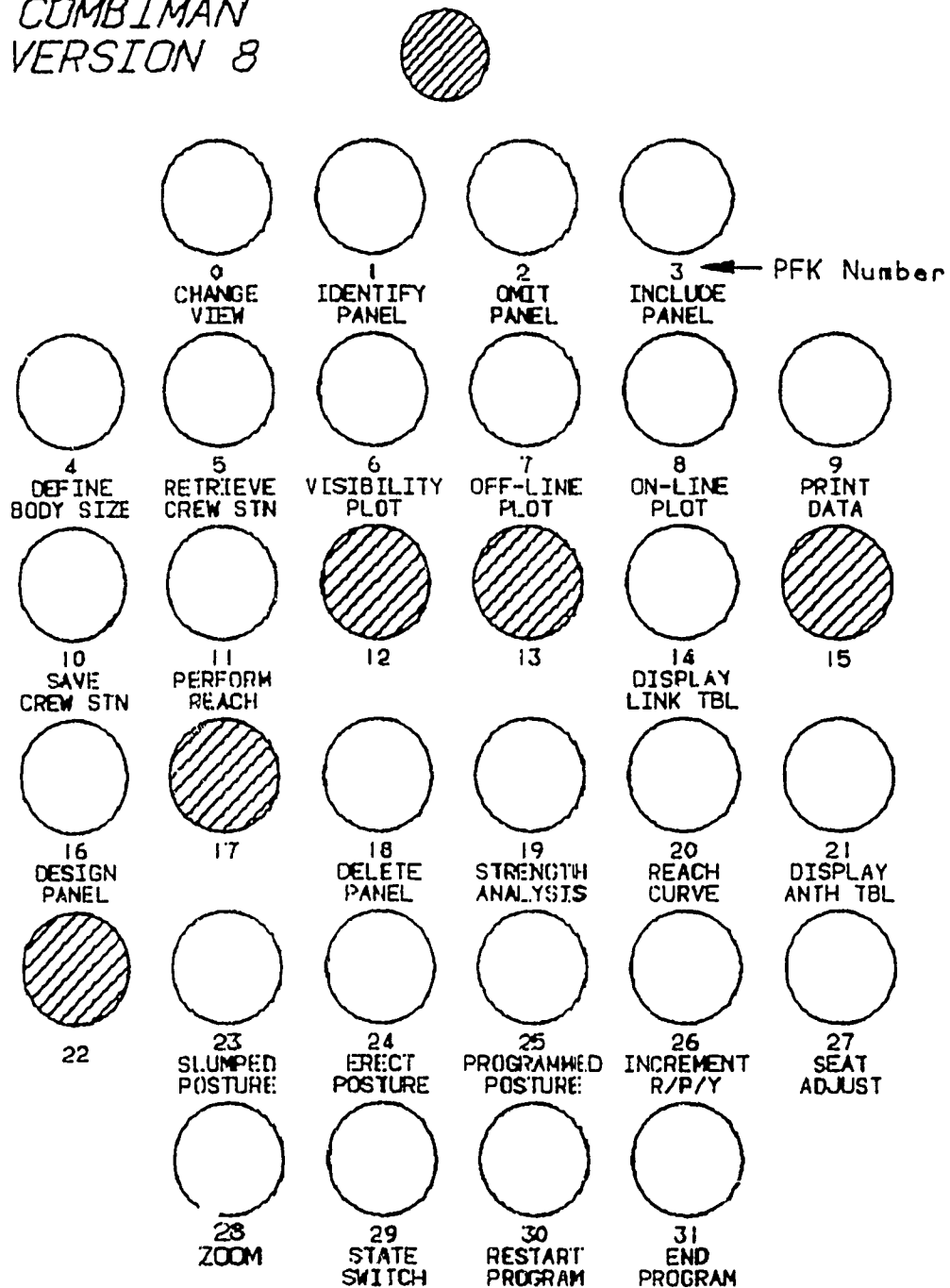


Figure 2.1. Program Function Keyboard (PFK) Overlay for CBM08. Shaded keys are not used or illuminated.

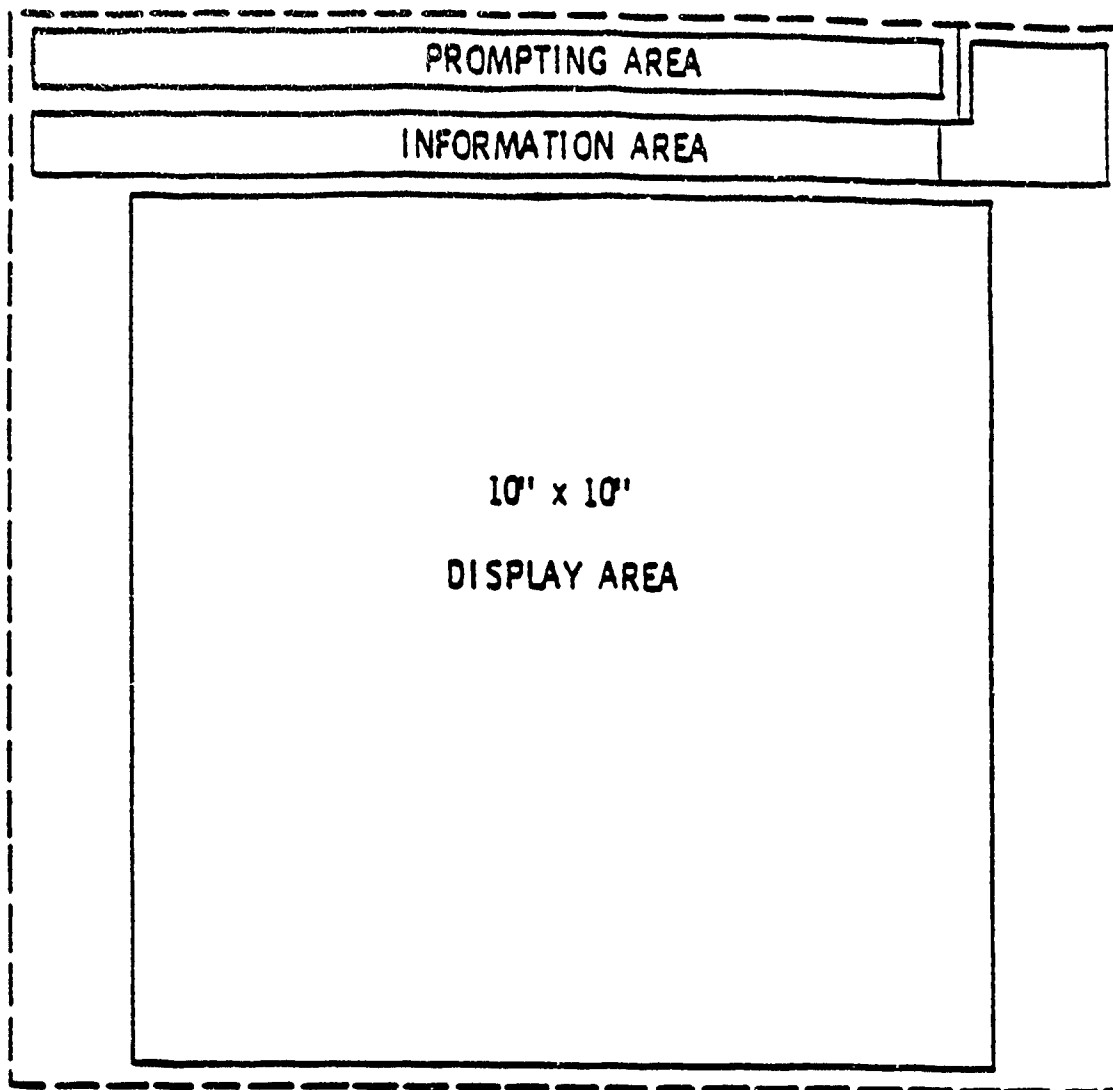


Figure 2.2. Format of ADAGE 4370 or IBM 2250 or 5080 Display Unit. The program adjusts the size of the displayed image to fill the 10" display area. Selecting a front view may cause the man-model and crew station to appear larger, but the coordinate information remains unchanged.



Figure 2.3. CRT Unit with Function Keys, Alphanumeric Keyboard and Light Pen

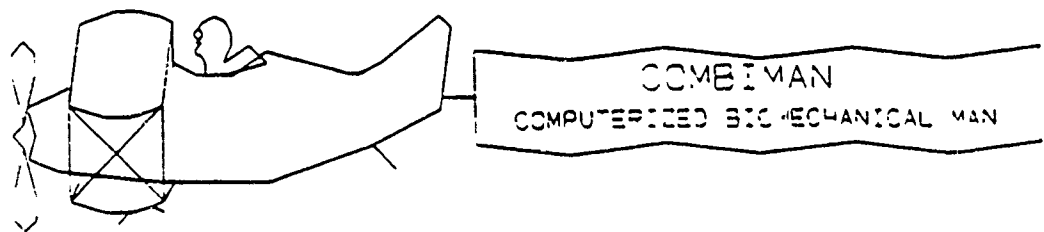
2.1 PROGRAM EXECUTION

Once the COMBIMAN program (CBM08) is submitted, the Anthropometric Survey Members, Crew Station Members and Vision Limit Overlays provided may be used to check out the operation of, and to gain experience in operating, the different functions. When the COMBIMAN program is initiated the COMBIMAN banner (Figure 2.4) appears. When the initialization is completed, the Define Body Size function (PFK 4) is automatically selected.

There are six pre-programmed anthropometric data base members to choose from.

1. R67 USAF - US Air Force Male Pilots and Navigators
2. R68 AFW - US Air Force Enlisted Women
3. R68 ArFW - US Air Force Female Pilots and Navigators
4. R70 ARMY - US Army Aviators
5. R77 ARMW - US Army Female Personnel
6. R64 NAVY - US Navy Flying Personnel

These anthropometric data base members are used to define body proportions and for automatic dimensioning and user input of body dimensions. The selection and editing of the six members are detailed in Appendix A. When the parameters of the man-model have been defined by the user the figure is generated by the program and appears fully enflashed on the screen. Appendix A explains the skeletal link system and enfleshment of the man-model; the joint mobility limits used by the program during automatic repositioning of the man-model; the derivation and application of the strength and clothing data. Appendix A also



DEVELOPED BY
AAMRL

CONTRACTOR
UDRI

Figure 2.4. COMBIMAN Banner.

contains user instructions for the Anthropometric Data Base Maintenance program (CBMAM). CBMAM is used to add user defined anthropometric data bases.

When the prompts to define the anthropometric body size, and clothing type, etc., have been answered, the function select prompt, DEPRESS PFK TO SELECT A FUNCTION, appears. The next step is to select the Retrieve Crew Station function by depressing PFK 5.

There are two crew station members pre-programmed on the tape; A7E-01 and A7--SEAT. The A7E-01 crew station member is the A7 crew station without a seat, and the A7--SEAT crew station member is the A7 seat only. The reason for this separation will be explained later. If you select the A7E-01 member, the screen will display both the crew station and the man-model. Appendix B provides details concerning the concepts used in developing crew stations and the instructions for using the Crew Station Data Base Maintenance program (CBMCM) to create additional crew station data bases.

The Visibility Analysis function (PFK 6) uses overlay data bases. The program, as you received it, includes three data bases.

- (1) BASELINE - which is the field-of-view with peripheral vision only.
- (2) HGU-26P and MBU-5/P - which is the field-of-view with the standard Air Force flying helmet and oxygen mask.
- (3) FIELD OF RESOLUTION - portrays the limits of visual acuity.

Appendix C has the instructions necessary for using the Vision Limit Overlay Data Base Maintenance program (CBMODM) to create additional data bases.

Go through the User's Guide and try each of the functions to learn how they work. Read the prompts carefully as some require an on screen selection, while others require a response from the ANKB. Typically, YES/NO questions and selections are made on screen, while data and alphanumerics are entered on the ANKB. Occasionally, the program pauses during the execution of a function to allow time to read and consider an intermediate step. At times the display area will be blank while the program is executing. At this time the "CREATING DISPLAY" message appears at the top of the screen.

2.2 ERROR PROCEDURES

The program performs some preliminary error checking on data supplied by the user. The majority of checking is for data values which are outside the limits built into the program. When the user selects or types values which are out of range, the program prompts the user to retry the entry.

Examples:

State Switch numbers must be between 1 and 72.

The maximum number of panels for any crew station configuration to be displayed cannot exceed 300.

All anthropometric dimensions must be entered in positive values.

Numerical values can be typed with or without a decimal point at the user's option.

Example:

"3", "3." and "3.0" will all be accepted by the program as 3.

If the program expects a whole number, decimal values are rounded off to the nearest integer.

Example:

"3.4" and "2.7" are rounded off and accepted by the program as 3.

If the program expects two decimal places, the input number is rounded off accordingly.

Example:

"11.32", "11.319" or "11.3215" would all be accepted as 11.32.

If a Program Function Key (PFK) is depressed the corresponding function is enabled. However, if a key is pressed erroneously, the following procedure may be followed to return to the main program.

For PFK 0, 1, 2, 3, 6, 7, 8, 11, 14, 16, 28 and 29 depress <CR> to cancel the selected function. The function select prompt reappears.

For PFK 4, 12, 13 and 27 the function must be executed.

For PFK 5, light-pen "*NONE" in the display to cancel execution of the function. The function select prompt appears.

2.3 ENDING THE PROGRAM

There are three ways to end the program. The primary method is by depressing PFK 31, (END COMBIMAN). This option can be

exercised only when the function select prompt, DEPRESS PFK TO SELECT A FUNCTION, appears in the Prompting Area of the CRT.

Another way to terminate execution of the program is with the CANCEL key on an IBM Alphanumeric Keyboard. When the CANCEL key and the ALT-CODE (CNTL and C keys on the ADAGE keyboard) are depressed together, the three options shown in Figure 2.5 are displayed. Selecting the TERMINATE option terminates the program without producing a memory dump for the program. The DUMP option terminates the program and produces a full storage dump. RESUME continues the execution of the program as though the CANCEL key has not been used. This option is provided by the system and can be used at any time.

The third option is to cancel the JOB from the computer operator's console. This a system dependent option.

< TERMINATE
< DUMP
< RESUME

Figure 2.5 Options Displayed on Depressing ALT-CODE
and CANCEL Keys Together.

SECTION 3

ANTHROPOMETRY RELATED FUNCTIONS

Anthropometry Related functions are used to define the body size, make necessary changes to the angles and dimensions of the internal skeletal links and to display the selected, or computed, values for the 12 anthropometric variables used to dimension the man-model.

3.1 DEFINE BODY SIZE FUNCTION (PFK 4)

The Define Body Size function is used to generate the display of the man-model in the correct body size and gender. A set of standard clothing ensembles is included in the selections to provide the correct appearance due to clothing bulk and fit. When using the "task related" analysis functions, the program internally modifies the joint mobility of the man-model due to the encumbrance of the selected clothing ensemble. When the COMBIMAN program is started the Define Body Size function is automatically pre-selected. It may also be called whenever the function selection prompt is displayed. When the function is activated, either by automatic pre-selection or by depressing PFK 4, the screen displays the Select Survey Member menu (Figure 3.1). There are six pre-programmed survey members included in the CBM08 program tape. Member names ending in "W" are for female personnel and the others are for male personnel. Details concerning the survey members and the appropriate selections are contained in Appendix A, paragraph A.5.

SELECT SURVEY MEMBER

SURVEY MEMBERS

R67 USAF

R68 AFW

R68 AFFW

R70 ARMY

R77 ARMW

R64 NAVY

Figure 3.1. Select Survey Member Menu

PROMPT: SELECT SURVEY MEMBER

ACTION: Select one of the members listed in the menu.

EXAMPLE: Select R67 USAF.

RESULT: The Select Dimensioning Option menu appears with the selected regression survey listed, indicating the means, standard deviations and percentiles for the anthropometric dimensions have been retrieved from the data base (Figure 3.2).

PROMPT: SELECT DIMENSIONING OPTION
FOR REGRESSION SURVEY R67 USAF

ACTION: Select one of the listed options. Option 1 (paragraph 3.1.1) should be used when the man-model should possess the body size characteristics of the population of crew members. Option 2 (paragraph 3.1.2) should be used when the man-model should possess the body size characteristics of a particular individual.

3.1.1 Option 1: Define Two Independent Variables Selected

EXAMPLE: Select OPTION 1

RESULT: The Select First Independent Variable menu appears (Figure 3.3).

PROMPT: SELECT FIRST INDEPENDENT VARIABLE

ACTION: Select any one variable from the lists of length or mass related variables. The two variable method allows the user to select the variable most relevant to the task analysis to be performed (the length related variable to define the skeletal system and the mass related variable to define the amount of enfleshment on the skeleton). For example, Sitting Height is most relevant for evaluating head clearance in the crew station and Eye Height-Sitting for evaluating vision requirements. Arm Length and Leg Length would be the most relevant variable for evaluating the operation of hand controls and rudder pedals, respectively. Weight would be selected as the first variable when gross enfleshment is most relevant, as in checking body clearance in a seat. Regression equations are used to define the other needed variables.

SELECT DIMENSIONING OPTION \
FOR REGRESSION SURVEY 67 USAF

- OPTION 1: DEFINE TWO INDEPENDENT VARIABLES
TWO INDEPENDENT VARIABLES ARE ASSIGNED VALUES. THE
DEPENDENT VARIABLES ARE CALCULATED USING REGRESSION
EQUATIONS. THIS PRODUCES A MAN MODEL THAT IS
REPRESENTATIVE OF THE SURVEY POPULATION.
- OPTION 2: DEFINE ALL TWELVE DEPENDENT VARIABLES
ALL TWELVE DEPENDENT VARIABLES ARE ASSIGNED VALUES.
THIS METHOD REPRESENTS A SPECIFIC INDIVIDUAL.

Figure 3.2. Select Dimensioning Option Menu

SELECT FIRST INDEPENDENT VARIABLE

INDEPENDENT VARIABLES				AVBL	AVBL
LENGTH RELATED	UNIT INPUT	MASS RELATED	UNIT INPUT	UNITS	PCTL
SITTING HEIGHT	IN	WEIGHT	LB	IN	1
					2
EYE HGT/SITTING	IN			CM	3
					5
ARM LENGTH	IN			MM	10
					15
KNEE HGT/SITTING	IN			LB	20
					25
BUTTOCK-KNE LGTH	IN			KG	30
					35
LEG LENGTH	IN				40
					45
					50
					55
					60
					65
					70
					75
					80
					85
					90
					95
					97
					98
					99

Figure 3.3. Select First Independent Variable Menu

EXAMPLE: Select SITTING HEIGHT

RESULT: The selected variable is underlined and the next prompt appears (Figure 3.4).

PROMPT: SELECT PERCENTILE, KEY IN A VALUE, OR SELECT DIFFERENT UNITS
KEY A VALUE FROM THE RANGE 33.94 TO 39.62

The range of values corresponds to the 1st to 99th percentile.

ACTION: Make one of the following selections or entries.

- A percentile from 1 to 99 may be selected from the "AVBL PCTL" (Available Percentile) column.

OR:

- Key in a value in inches within the range given.

OR:

- Select a different unit from the "AVBL UNITS" (Available Units) column. English and metric units may be mixed as the program converts metric units to English.

EXAMPLE: Select CM from AVBL UNITS column.

RESULT: The unit selected, CM, appears in the UNIT column, and the value range for the variable is presented in centimeters, the unit selected, with the rest of the prompt remaining the same (Figure 3.5).

PROMPT: SELECT PERCENTILE, KEY IN A VALUE, OR SELECT DIFFERENT UNITS
KEY A VALUE FROM THE RANGE 86.21 TO 100.63

ACTION: Make one of the following selections or entries.

- Select a percentile from the AVBL PCTL column.

OR:

- Key in a value within the range given.

OR:

- Select a different unit from the AVBL UNITS column.

EXAMPLE: Key in 93.35, followed by <CR>.

SELECT PERCENTILE, KEY IN A VALUE, OR SELECT DIFFERENT UNITS
 KEY A VALUE FROM THE RANGE 33.94 TO 39.62

INDEPENDENT VARIABLES				AVBL	AVBL		
LENGTH RELATED	UNIT	INPUT	MASS RELATED	UNIT	INPUT	UNITS	PCTL
<u>SITTING HEIGHT</u>	IN	—	WEIGHT	LB		IN	1
							2
EYE HGT/SITTING	IN					CM	3
							5
ARM LENGTH	IN					MM	10
							15
KNEE HGT/SITTING	IN					LB	20
							25
BUTTOCK-KNE LGTH	IN					KG	30
							35
LEG LENGTH	IN						40
							45
							50
							55
							60
							65
							70
							75
							80
							85
							90
							95
							97
							98
							99

Figure 3.4. Select Percentile, Key in Value, or Select Different Units Menu for First Independent Variable.

SELECT PERCENTILE, KEY IN A VALUE, OR SELECT DIFFERENT UNITS
 KEY A VALUE FROM THE RANGE 86.21 TO 100.63

INDEPENDENT VARIABLES						AVBL	AVBL
LENGTH RELATED	UNIT	INPUT	MASS RELATED	UNIT	INPUT	UNITS	PCTL
<u>SITTING HEIGHT</u>	CM	—	WEIGHT	LB		IN	1
							2
EYE HGT/SITTING	IN					CM	3
							5
ARM LENGTH	IN					MM	10
							15
KNEE HGT/SITTING	IN					LB	20
							25
BUTTOCK-KNE LGTH	IN					KG	30
							35
LEG LENGTH	IN						40
							45
							50
							55
							60
							65
							70
							75
							80
							85
							90
							95
							97
							98
							99

Figure 3.5. Selection Menu for First Independent Variable, with Units Changed to CM.

RESULT: The entered value appears under the input column, and the mass related variable is underlined. The next prompt appears (Figure 3.6).

PROMPT: SELECT A PERCENTILE FROM THE RANGE 5 TO 95
KEY A VALUE FROM THE RANGE 140.15 TO 210.76
OR SELECT DIFFERENT UNITS

The program places realistic constraints on the values for the second variable. This range is set at + 1.65 standard deviations from the best estimate derived from value entered (as a percentile or engineering value) for the first variable.

ACTION: Make one of the following selections or entries.

- Select a percentile within the given range.

OR:

- Key in a value within the given range.

OR:

- Select a different unit from the AVBL UNITS column.

EXAMPLE: Select 50 from the AVBL PCTL column.

RESULT: 50 momentarily appears in the INPUT column and the Select Clothing Type menu appears (Figure 3.7). If a different unit had been selected, the range of values figures change to values for the selected unit. Variable value is input as before.

PROMPT: SELECT CLOTHING TYPE

ACTION: Select any one of the seven choices (see Appendix A for descriptions). There are six different clothing types, plus a semi-clad baseline condition. The man-model will be displayed with the bulk of the clothing type selected. Any encumbrances to joint mobility parameters, associated with the clothing type selected, are automatically entered into the program.

EXAMPLE: Select SUMMER SUIT

RESULT: The man-model and the function select prompt are displayed. The regression member (R67 USAF) and Survey (67 USAF) used in defining the man-model, the clothing type selected, the default helmet type, posture and mobility parameters are displayed in the information area (Figure 3.8).

SELECT A PERCENTILE FROM THE RANGE				5	TO	95	
KEY A VALUE FROM THE RANGE				140.15	TO	210.76	
INDEPENDENT VARIABLES							
LENGTH RELATED	UNIT	INPUT	MASS RELATED	UNIT	INPUT	AVBL UNITS	AVBL PCTL
SITTING HEIGHT	CM	93.35	<u>WEIGHT</u>	LB	—	IN	1
EYE HGT/SITTING	IN					CM	2
ARM LENGTH	IN					MM	3
KNEE HGT/SITTING	IN					LB	5
BUTTOCK-KNE LGTH	IN					KG	10
LEG LENGTH	IN						15
							20
							25
							30
							35
							40
							45
							50
							55
							60
							65
							70
							75
							80
							85
							90
							95
							97
							98
							99

Figure 3.6. Percentile, Value or Different Unit Menu for the Second Variable

SELECT CLOTHING TYPE

SEMICLAD

SUMMER SUIT

SUMMER SUIT W/VEST

WINTER SUIT

WINTER SUIT W/VEST

WINTER SUIT W/VEST JACKET AND LIFE PRESERVER

CHEMICAL DEFENSE

Figure 3.7. Select Clothing Type Menu

DEPRESS PFX TO SELECT A FUNCTION.

AREA
 11/11/71

DEPRESS PFX	USAF SUPERVISOR	USAF	POST	POSTURE	MOBILITY	OFF-1113
11/11/71	11/11/71	11/11/71	11/11/71	11/11/71	11/11/71	11/11/71
11/11/71	11/11/71	11/11/71	11/11/71	11/11/71	11/11/71	11/11/71

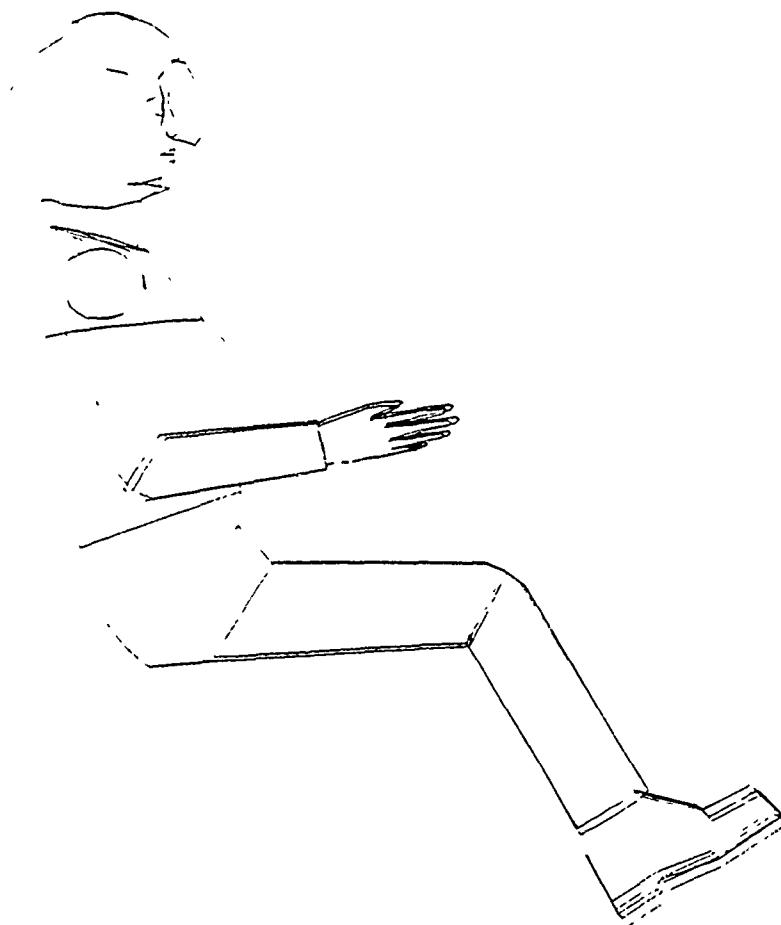


Figure 3.8. Man-Model Display, as Generated by Option 1,
 DEFINE TWO INDEPENDENT VARIABLES

3.1.2 OPTION 2: Define All Twelve Dependent Variables

Option 2 should be used when the man-model should possess the body size characteristics of a particular individual.

EXAMPLE: Select OPTION 2

RESULT: The Define Twelve Dependent Variable menu and prompt appears (Figure 3.9). The first variable is underlined and the default value is listed under the UNIT column.

PROMPT: SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A
DIFFERENT UNIT

ACTION: Make one of the following selections or entries.

- Select a percentile from the AVBL PCTL (Available Percentile) column.

OR:

- Key in a value, followed by <CR>.

NOTE: Unlike Option 1 there is no range of values for the remaining variables. There is no protection from entering unrealistic values. Caution must be used under Option 2 when defining variable values to preclude generating an unrealistic man-model and display.

OR:

- Select a different unit from the AVBL UNITS (Available Units) column.

NOTE: Percentiles, English and metric units can be intermixed, as the program converts and computes values in inches and pounds.

EXAMPLE: Select 50 from the AVBL PCTL column.

RESULT: The second variable is underlined, with the prompt remaining the same. The defined value for the first variable appears under the INPUT column.

PROMPT: SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A
DIFFERENT UNIT

ACTION: The action choices are the same as for the first variable.

SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A DIFFERENT UNIT

DEPENDENT VBLS	UNIT	INPUT	AVBL UNITS	AVBL PCTL
<u>WEIGHT</u>	LB	—	IN	1
				2
SITTING HEIGHT			CM	3
				5
ACROMION HGT/SIT			MM	10
				15
SHOULDER-ELB LGTH			LB	20
				25
KNEE HGT/SITTING			KG	30
				35
BUTTOCK-KNE LGTH				40
				45
BIACROMIAL BRDTH				50
				55
HIP BREADTH				60
				65
CHEST DEPTH				70
				75
FOOT LENGTH				80
				85
HAND LENGTH				90
				95
ELBOW-WRIST LGTH				97
				98
				99

Figure 3.9. Define Twelve Dependent Variables Menu

EXAMPLE: Select CM from the AVBL UNITS column.

RESULT: The prompt remains the same, but the UNIT column lists the different unit selected (Figure 3.10).

PROMPT: SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A
DIFFERENT UNIT

ACTION: The variable is defined using any one of the three choices previously explained.

EXAMPLE: Key in 100.0, followed by <CR>.

RESULT: Value keyed in appears under the INPUT column, the next variable is underlined, and the prompt remains the same (Figure 3.11).

PROMPT: SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A
DIFFERENT UNIT

ACTION: Define values for the remaining 12 dependent variables by selecting percentiles, different units, and/or keying values.

RESULT: When all 12 dependent variables have been defined, the Select Clothing Type menu appears (see Figure 3.7).

PROMPT: SELECT CLOTHING TYPE

ACTION: Select any one of the seven choices.

EXAMPLE: Select SUMMER SUIT.

RESULT: The man-model and function select prompt are displayed (Figure 3.12). The man-model displayed in Figure 3.12 was generated from the INPUT values shown in Figure 3.13.

NOTE: The 12 dependent variables may be defined from a card format file. This capability allows the user to enter the data for the same individual repeatedly, or to represent an individual at the extreme variations of body proportions. The capability is controlled by State Switch 9, PFK 29. Set State Switch 9 set to "ON", prior to selecting PFK 4. When PFK 4 is depressed, the Select Survey Member menu is displayed (see Figure 3.1). When a Survey Member Name is selected, the following prompt appears.

SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A DIFFERENT UNIT

DEPENDENT VBLS	UNIT	INPUT	AVBL UNITS	AVBL PCTL
WEIGHT	LB	50 PCT	IN	1
				2
<u>SITTING HEIGHT</u>	CM	—	MM	3
				5
ACROMION HGT/SIT			MM	10
				15
SHOULDER-ELB LGTH			LB	20
				25
KNEE HGT/SITTING			KG	30
				35
BUTTOCK-KNE LGTH				40
				45
BIACROMIAL BRDTH				50
				55
HIP BREADTH				60
				65
CHEST DEPTH				70
				75
FOOT LENGTH				80
				85
HAND LENGTH				90
				95
ELBOW-WRIST LGTH				97
				98
				99

Figure 3.10. Define Second Variable, after
Different Unit is Selected.

SELECT A PERCENTILE, KEY IN A VALUE, OR SELECT A DIFFERENT UNIT

DEPENDENT VBLS	UNIT	INPUT	AVBL UNITS	AVBL PCTL
WEIGHT	LB	50 PCT	IN	1
				2
SITTING HEIGHT	CM	100.0	CM	3
				5
<u>ACROMION HGT/SIT</u>	IN	—	MM	10
				15
SHOULDER-ELB LGTH			LB	20
				25
KNEE HGT/SITTING			KG	30
				35
BUTTOCK-KNE LGTH				40
				45
BIACROMIAL BRDTH				50
				55
HIP BREADTH				60
				65
CHEST DEPTH				70
				75
FOOT LENGTH				80
				85
HAND LENGTH				90
				95
ELBOW-WRIST LGTH				97
				98
				99

Figure 3.11. Define Third Dependent Variable

```

DEPRESS DATA TO SELECT - FUNCTION.
                                     .SEA
                                     /  \
DEPRESS DATA SURVEY AT USAP 1987
DEPRESS DATA SUMMER HELMET TYPE -1.223 POSTURE MOBILITY DEPRESS
DEPRESS DATA -180 DEPRESS DATA DEPRESS DATA DEPRESS DATA

```

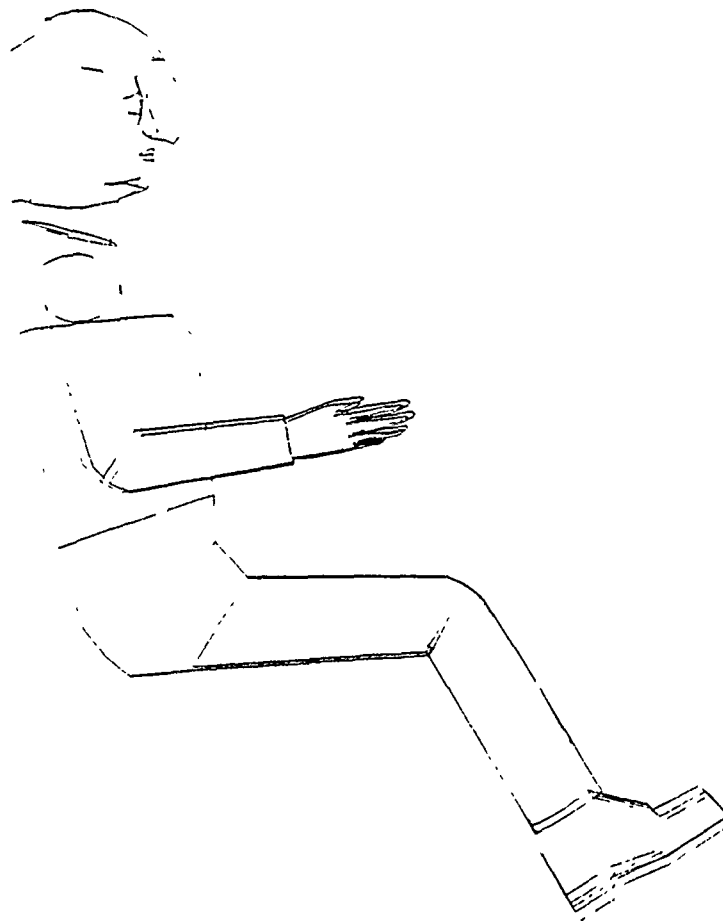


Figure 3.12 Man-Model Display, as Generated by Option 2,
DEFINE ALL TWELVE DEPENDENT VARIABLES

DEPRESS CR TO CONTINUE										VIEW		
										XY	XZ	YZ
REGRESS R67 USAF SURVEY 67 USAF CRST												
FLIGHT SUIT SUMMER HELMET TYPE -GU26P										POSTURE MOBILITY		
SEAT TYPE -ARD OFF(0 0 0 0 0 0)										SLUMPED ARM OFF-AXIS		

USER INPUT TWELVE DEPENDENT VARIABLES

NO	VARIABLE NAME	UNIT	INPUT		COMPUTED	
			VALUE	UNIT	VALUE	UNIT
1	WEIGHT	LB	120 00		132 00	LB
2	SITTING HEIGHT	IN	75 PCT		37 53	IN
3	ACROMION HGT/SIT	IN	40 PCT		23 73	IN
4	SHOULDR-ELB LGTH	IN	50 PCT		14 14	IN
5	KNEE HGT/SITTING	IN	30 PCT		21 94	IN
6	BUTTOCK-KNE LGTH	IN	90 PCT		25 14	IN
7	BIACROMIAL BPDTH	IN	50 PCT		16 05	IN
8	HIP BREADTH	IN	50 PCT		13 86	IN
9	CHEST DEPTH	IN	55 PCT		9 75	IN
10	FOOT LENGTH	IN	55 PCT		10 69	IN
11	HAND LENGTH	IN	60 PCT		7 60	IN
12	ELBOW-WRIST LGTH	IN	70 PCT		12 09	IN

Figure 3.13. Twelve Dependent Variable Values Input to Generate Man-Model Display in Figure 3.12.

PROMPT: SELECT SOURCE OF ANTHROPOMETRIC DATA
 CARDS COMBIMAN DATA BASE

ACTION:

- Select CARDS

OR:

- Select COMBIMAN DATA BASE

EXAMPLE: Select COMBIMAN DATA BASE

RESULT: The prompt to define the first of 12 dependent variables appears (see Figure 3.9) and the definition of the 12 variables is accomplished as previously explained. If CARDS is selected the file is read directly from the system input device and the man-model is generated and displayed.

3.2 DISPLAY LINK TABLE FUNCTION (PFK 14)

The Display Link Table function provides the user the opportunity to inspect the table of link dimensions and angles and make changes to any or all of the values. The table displays internal link vector lengths, rather than anthropometric surface dimensions. Since there is no protection against entering unrealistic values in this table, changes in vector lengths and joint angles should be made with caution, because unrealistic body proportions may result. Figure 3.14 shows an example of a Display Table.

Other than the choices of Slumped (paragraph 7.5) or Erect (paragraph 7.6) posture, and the reposturing in the Reach Analysis function, using the Display Link Table function to change the joint angles is the user's most important method to change the body position of the man-model. To properly use this table, refer to Table 3.1 for link definitions. Figure 3.15 is a diagram of the link system with index link numbers corresponding to Table 3.1.

The link system is the sum of a series of vectors. Each link vector has a local coordinate system with its origin at the distal end. The orientation of the next link is defined in this local coordinate system. Phi, Theta, and Psi correspond to Euler angles as shown in Figure 3.16. Since these local coordinate systems are usually not aligned with the base system which has its origin at the Seat Reference Point (SRP), no rule can be given for selecting a particular direction of movement. The user

SELECT VALUE YOU WANT TO CHANGE

--LINK--	LENGTH	-PHI-	-THETA-	-PSI-
SRP	0 0	0 0	0 0	0 0
SRP-MHIP	5 75	0 0	46 20	0 0
MHIP-L34	5 18	0 0	-67 20	0 0
CHEST	9 47	0 0	4 80	0 0
T89-T1	7 49	0 0	10 00	0 0
NECK	5 21	0 0	20 00	0 0
NECK-MHD	1 40	0 0	-14 30	0 0
MHD-MEYE	0 34	0 0	00 00	0 0
MEYE-RSEY	1 25	-90 00	12 00	0 0
MEYE-LEF	1 25	90 00	00 00	0 0
T1-MSS	3 23	0 0	115 00	0 0
MSS-RSS	1 00	-90 00	90 00	29 30
RSS-RSLD	8 26	35 00	22 00	0 0
RSLDR	0 0	0 0	-22 00	-125 00
RUPARM	10 93	0 0	-90 00	-90 00
RLWARM	10 56	0 0	90 00	0 0
RGRIP	2 00	0 0	0 0	0 0
RFNRCH	4 69	0 0	0 0	0 0
RFNGRTIP	7 52	0 0	0 0	0 0
MSS-LSS	1 00	90 00	90 00	-29 30
LSS-LSLD	8 26	-35 00	22 00	0 0
LSLDR	0 0	0 0	-22 00	125 00
LUPARM	10 93	0 0	-90 00	90 00
LLWRARM	10 56	0 0	90 00	0 0
LGRIP	2 00	0 0	0 0	0 0
LFNRCH	4 69	0 0	0 0	0 0
LFNGRTIP	7 52	0 0	0 0	0 0
MHIP-RUP	3 43	-90 00	90 00	53 70
RUPRLEG	17 02	84 00	90 00	-90 00
RLWRLEG	16 15	0 0	60 00	0 0
RANKLE	2 21	0 0	0 0	0 0
MHIP-LHP	3 43	90 00	90 00	-53 70
LUPRLEG	17 02	-84 00	90 00	90 00
LLWRLEG	16 15	0 0	60 00	0 0
LANKLE	2 21	0 0	0 0	0 0

Figure 3.14. Display Link Table. Displays Links, their Lengths, and Euler Angles.

TABLE 3.1. LINK TABLE DEFINITIONS

<u>LINK NO.</u>	<u>NAME</u>	<u>DEFINITION</u>
1	SRP	Zero-length link at the Seat Reference Point for orientation
2	SRP-MHIP	SRP to mid-hip
3	MHIP-L34	Mid-hip to L3/L4 disc
4	CHEST	L3/L4 disc to T8/T9 disc
5	T89-T1	T8/T9 disc to T1 vertebra
6	NECK	T1 vertebra to atlas
7	NECK-MHD	Atlas to mid-head point
8	MHD-MEYE	Mid-head point to mid-eye point
9	MEYE-REY	Mid-eye point to right eye
10	MEYE-LEY	Mid-eye point to left eye
11	T1-MSS	T1 vertebra to mid-suprasternale
12	MSS-RSS	Mid-suprasternale to right suprasternale
13	RSS-RSLD	Right suprasternale to right shoulder
14	RSLDR	Zero-length link at the right shoulder for orientation
15	RUPARM	Right shoulder to right elbow
16	RLWARM	Right elbow to right wrist
17	RGRIP	Right wrist to grip center point
18	RFNRCH	Right grip center point to functional reach point
19	RFNGRTIP	Right functional reach point to fingertip reach point
20	MSS-LSRD	Mid-suprasternal to left shoulder
21	LSS-LSLD	Left suprasternal to left shoulder
22	LSLDR	Zero-length link at the left shoulder for orientation
23	LUPRARM	Left shoulder to left elbow
24	LLWRARM	Left elbow to left wrist
25	LGRIP	Left wrist to grip center point
26	LFNRCH	Left grip center point to functional reach point
27	LFNGRTIP	Left functional reach point to fingertip reach point
28	MHIP-RHP	Mid-hip to right hip
29	RUPRLEG	Right hip to right knee
30	RLWRLEG	Right knee to right ankle
31	RANKLE	Right ankle to bottom of the right foot
32	MHIP-LHP	Mid-hip to left hip
33	LUPRLEG	Left hip to left knee
34	LLWRLEG	Left knee to left ankle
35	LANKLE	Left ankle to bottom of left foot

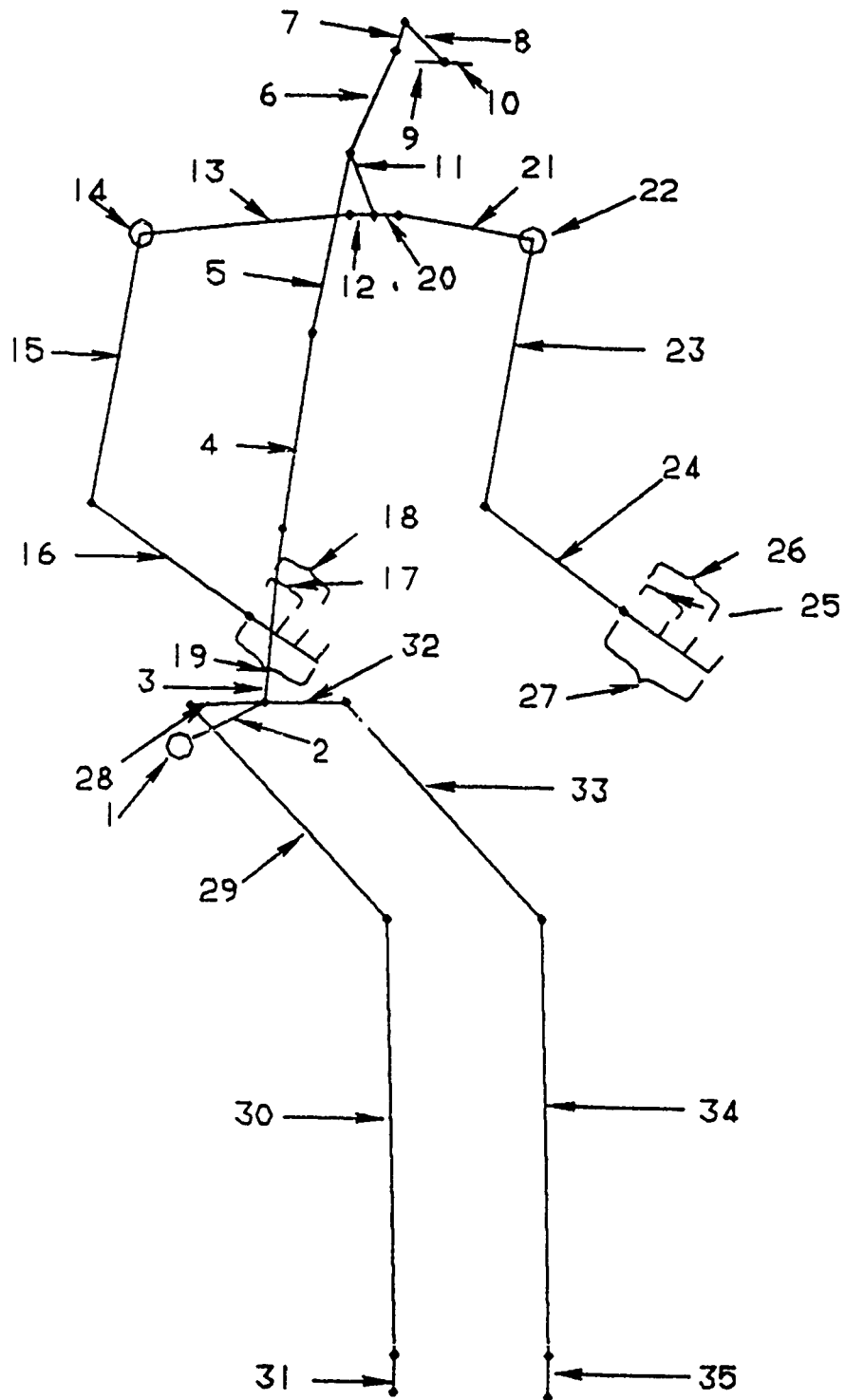
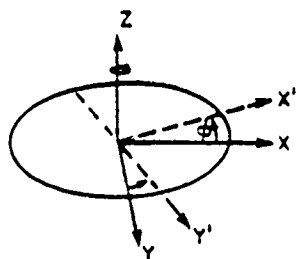
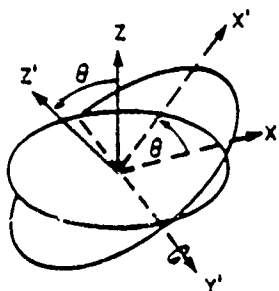
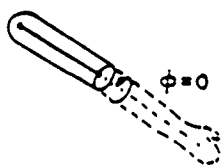


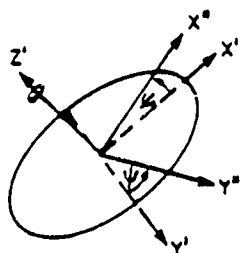
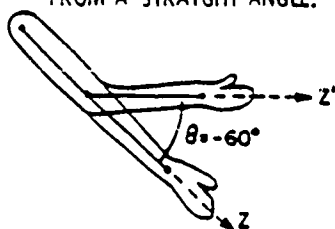
Figure 3.15. Link System Diagram



1st ROTATION ABOUT THE Z AXIS
 DEFINES THE JOINT ROTATION
 AXIS. FOR ELBOW, $\phi = 0^\circ$
 BECAUSE THIS ANGLE WAS
 ESTABLISHED BY ψ FROM
 THE PREVIOUS SYSTEM. (THE
 ELBOW IS ROTATED BY THE
 UPPER ARM).



2nd ROTATION ABOUT THE NEWLY FORMED
Y' AXIS. FOR THE ELBOW,
 THIS ANGLE θ IS THE DEVIATION
 FROM A STRAIGHT ANGLE.



3rd ROTATION ABOUT THE Z' AXIS
 REPRESENTS THE ROTATION OF
 THE DISTAL END OF LINK, OR
 IN THE CASE OF THE ELBOW
 SYSTEM, IT IS THE ROTATION
 OF THE FOREARM.

RIGHT ARM

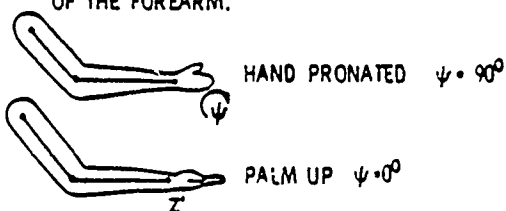


Figure 3.16. Example of Euler Angle Changes for Elbow Joints.

should try angular changes one-by-one to obtain desired results. Some general relationships do exist and are listed here.

1. To turn the COMBIMAN head to the left/right, increase/decrease the value of Psi of NECK-MHD link.
2. To rotate the COMBIMAN head upwards/downwards, decrease/increase the value of Theta of NECK-MHD.
3. To raise/lower the forearms, increase/decrease the values of Theta of both RLWARM and LLWRARM.
4. To raise/lower the upper arms out from the side, increase/decrease the value of Theta of both RUPARM and LUPARM.
5. To raise/lower the upper arms out in front of COMBIMAN, increase/decrease the value of Phi of RUPARM and decrease/increase the value of Phi of LUPARM.

Any change made in link length is reflected in the man-model for all postures. However, changes made in angles are saved in the Programmed posture and used only to display the Programmed Posture.

The user can modify the values in the Display Table by selecting the value to be changed, keying in a new value, and depressing the <CR> key. When all desired changes are made, the user depresses the <CR> key again to display the new man-model. The transformation angles in this display can be modified to place the man-model in any desired position.

Any changes made in the Link Table are automatically saved and may be recalled by the Reset Programmed Posture function, PFK 25. So if the user manually repositions the orientation angles, and then changes them using the Erect Posture, Slumped Posture, or Perform Reach functions, the Programmed Posture may

be recalled by depressing PFK 25 when the Function Select prompt appears.

At the start of any COMBIMAN program session, the values for the link tables are defaulted to the Slumped posture. The following is an example of changing angular values.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 14 to display the link table.

RESULT: Screen displays the Link Table, with the link lengths and angles, and the next prompt at the top of the display area (see Figure 3.14).

PROMPT: SELECT VALUE YOU WANT TO CHANGE

ACTION: Select the length or angle for the link to be changed.

EXAMPLE: Select 4.80 under the THETA column for the CHEST link.

RESULT: The value of THETA (4.80) for the CHEST is underlined and the next prompt appears (Figure 3.17).

PROMPT: ENTER NEW VALUE

ACTION: Enter desired value <CR>.

EXAMPLE: Enter 27.96 and then <CR>.

RESULT: 28.0 is displayed as the new value of Theta for the CHEST link, and the next prompt appears.

PROMPT: SELECT VALUE YOU WANT TO CHANGE

ACTION: Additional link lengths or angles may be changed at this time by following the procedure previously outlined.

OR:

If all desired changes have been completed, depress <CR> to exit the function.

ENTER NEW VALUE

--LINK--	LENGTH	-PHI-	-THETA-	-PSI-
SRP	0 0	0 0	0 0	0 0
SRP-MHIP	5 75	0 0	46 20	0 0
MHIP-L34	5 18	0 0	-67 20	0 0
CHEST	9 47	0 0	4 30	0 0
T89-T1	7 49	0 0	10 30	0 0
NECK	5 21	0 0	20 30	0 0
NECK-MHD	1 40	0 0	-14 30	0 0
MHD-MEYE	3 34	0 0	90 30	0 0
MEYE-PEY	1 25	-90 00	00 30	0 0
MEYE-LE	1 25	90 00	00 30	0 0
T1-MSS	3 23	0 0	115 30	0 0
MSS-RSS	1 00	-90 00	90 30	29 30
RSS-RSLD	8 26	35 00	22 30	0 0
RSLDR	0 0	0 0	-22 30	-125 00
RUPARM	10 93	0 0	-90 30	-90 00
RLWARM	10 56	0 0	90 30	0 0
RGRIP	2 00	0 0	0 0	0 0
RFNRCH	4 69	0 0	0 0	0 0
RFNGRTIP	7 52	0 0	0 0	0 0
MSS-LSS	1 00	90 00	90 30	-29 30
LSS-LSLD	8 26	-35 00	22 30	0 0
LSLDR	0 0	0 0	-22 30	125 00
LUPARM	10 93	0 0	-90 30	90 00
LLWRARM	10 56	0 0	90 30	0 0
LGRIP	2 00	0 0	0 0	0 0
LFNRCH	4 69	0 0	0 0	0 0
LFNGRTIP	7 52	0 0	0 0	0 0
MHIP-PLP	3 43	-90 00	90 30	53 70
RUPRLEG	17 02	84 00	90 30	-90 00
RLWRLEG	16 15	0 0	60 30	0 0
RANKLE	2 21	0 0	0 0	0 0
MHIP-LHP	3 43	90 00	90 30	-53 70
LUPRLEG	17 02	-84 00	90 30	90 00
LLWRLEG	16 15	0 0	60 30	0 0
LANKLE	2 21	0 0	0 0	0 0

Figure 3.17. DISPLAY LINK TABLE, with Prompt to Enter New Value.

EXAMPLE: For this example change the values for the link angles as follows:

RSS-RSLD	-	PHI	to	44.29
		THETA	to	19.84
RSLDR	-	THETA	to	-19.84
		PSI	to	-134.90
RUPARM	-	PHI	to	-113.40
	-	THETA	to	76.53
	-	PSI	to	95.66
RLWARM	-	THETA	to	4.98
LSS-LSD	-	PHI	to	-33.35
		THETA	to	22.47
LSLDR	-	THETA	to	-22.47
		PSI	to	123.35
LUPARM	-	PHI	to	113.92
		THETA	to	76.68
		PSI	to	-95.84
LLWRARM	-	THETA	to	5.13

When all angles have been changed and confirmed, depress <CR>.

RESULT: Man-model is displayed in the Programmed posture as shown in Figure 3.18 and the function terminates. These angle changes are saved in the Programmed Posture function. The man-model can be repostured to the Slumped posture (PFK 23), then returned to the programmed posture by depressing PFK 25 (Reset Programmed Posture function) to recall the saved angle changes.

DEPRESS PFK TO SELECT A FUNCTION										VIEW		
										XY	XZ	YZ
REGRESS R67	USAF	SURVEY 67	USAF	CRST						POSTURE	MOBILITY	OFF-AXIS
FLIGHT SUIT	SUMMER	HELMET TYPE	HGU26P						PRGM'D	ARM		
SEAT TYPE	HARD	OFF(	0 0	0 0	0 0							

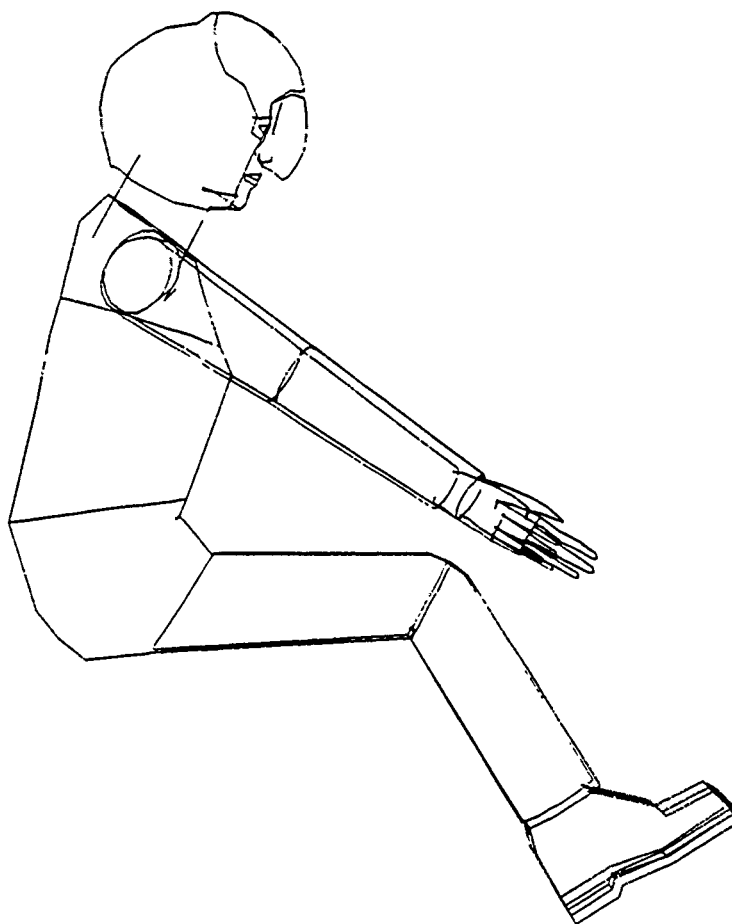


Figure 3.18 Man-model in the Programmed Posture

3.3 DISPLAY ANTHROPOMETRIC TABLE FUNCTION (PFK 21)

The Display Anthropometric Table function displays the anthropometric variables selected and values assigned/computed when defining the body size of the man-model. It is useful to review the body size definition of the man-model currently being used in analyses. The function may be called when the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress **PFK 21** to initiate the Display Anthropometric Table function.

RESULT: The COMBIMAN display is removed from the screen and the Anthropometric Table (Figures 3.19 and 3.20) is displayed on the screen and the next prompt appears.

PROMPT: DEPRESS CR TO CONTINUE

ACTION: After perusing the data in the Anthropometric Table depress **<CR>**.

RESULT: Function terminates.

DEPRESS OR TO CONTINUE						VIEW		
						XY	XZ	YZ
REGRESS R67 USAF SURVEY 67 USAF	CRST							
FLIGHT SUIT SUMMER	HELMET TYPE	-GU26P	POSTURE	MOBILITY	OFF-AXIS			
SEAT TYPE	-ARD	OFF(0 0 0 0 0 0)	SLUMPED	ARM				

USER INPUT TWO INDEPENDENT VARIABLES

Z SCORE 1 65

VARIABLE NAME	INPUT	COMPUTED
SITTING HEIGHT	50 PCT	36 65 IN
WEIGHT	50 PCT	172 42 LB

COMPUTED ANTHROPOMETRIC DIMENSIONS

NO	VARIABLE NAME	VALUE	UNIT
1	WEIGHT	172 42	LB
2	SITTING HEIGHT	36 65	IN
3	ACROMION HGT/SIT	24 01	IN
4	SHOULDR-ELB LGTH	14 14	IN
5	KNEE HGT/SITTING	21 94	IN
6	BUTTOCK-KNEE LGTH	23 77	IN
7	BIACROMIAL BPDTH	16 02	IN
8	HIP BREADTH	13 85	IN
9	CHEST DEPTH	9 62	IN
10	FOOT LENGTH	10 63	IN
11	HAND LENGTH	7 52	IN
12	ELBOW-WRIST LGTH	11 80	IN

Figure 3.19. Display Anthropometric Table Function.
Input Two Variables.

DEPRESS CR TO CONTINUE										VIEW		
										XY	XZ	YZ
REGRESS R67 USAF SURVEY 67 USAF CRST												
FLIGHT SUIT SUMMER HELMET TYPE HGU26P										POSTURE		
SEAT TYPE HARD OFF(0 0 0 0 0 0)										SLUMPED		
										MOBILITY		
										ARM		
										OFF-AXIS		

USER INPUT TWELVE DEPENDENT VARIABLES

NO	VARIABLE NAME	UNIT	INPUT		COMPUTED	
			VALUE	UNIT	VALUE	UNIT
1	WEIGHT	LB	50 PCT		172 42	LB
2	SITTING HEIGHT	IN	70 PCT		37 33	IN
3	ACROMION HGT/SIT	IN	40 PCT		23 73	IN
4	SHOULDR-ELB LGTH	IN	45 PCT		14 06	IN
5	KNEE HGT/SITTING	IN	80 PCT		22 77	IN
6	BUTTOCK-KNE LGTH	IN	50 PCT		23 76	IN
7	BIACROMIAL BRDTH	IN	25 PCT		13 54	IN
8	HIP BREADTH	IN	30 PCT		13 86	IN
9	CHEST DEPTH	IN	60 PCT		9 85	IN
10	FOOT LENGTH	IN	65 PCT		12 81	IN
11	HAND LENGTH	IN	30 PCT		7 51	IN
12	ELBOW-WRIST LGTH	IN	40 PCT		11 66	IN

Figure 3.20. Display Anthropometric Table Function, Input 12 Variables. If input values are actual measurements, the computed value column is blank.

SECTION 4

CREW STATION RELATED FUNCTIONS

The Crew Station Related functions are used to access the Crew Station data base to display and manipulate a crew station on the CRT. Due to the sequencing of the program, the man-model is generated first and the crew station second. If the user wants to display a crew station without the man-model, State Switch 5, must be placed "ON" (reference PFK 29). Once the crew station is displayed, with or without the man-model, the Crew Station Related functions can be used to reposition the seat, or temporarily delete and add panels. The data bases for two crew station members, the A7E-01 and the A7--SEAT, are included on the tape you received. These two crew station members will be used as examples in the instructions for operating the Crew Station Related functions. Other crew station members may be created by following the instructions in Appendix B.

4.1 RETRIEVE CREW STATION FUNCTION (PFK 5)

The Retrieve Crew Station function allows the user to retrieve a crew station member from the Crew Station Data Base and display it on the screen. The function can be called at any time the screen displays the Function Select prompt.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 5 to initiate the Retrieve Crew Station function.

RESULT: The menu of crew station members is displayed with the next prompt (Figure 4.1).

SELECT CREWSTATION MEMBER

CREW STATION MEMBER

A7E-01

A7--SEAT

ERASE

NONE

Figure 4.1. Retrieve Crew Station Member Menu

PROMPT: SELECT CREW STATION MEMBER

ACTION: Select the member name of the crew station to be displayed. Crew station member names listed in the first column may, or may not, include a seat. If the crew station member represents a seat only, the last four characters of its member name must be SEAT, and will be listed in the second column. On the user's tape the A7E-01 member is the A7 crew station without a seat, and the A7--SEAT member is the A7 seat only. This separation of the crew station and crew station seat is provided for the convenience of the user. The same seat, such as the ACES II ejection seat, may be used in more than one crew station. By creating the seat as a separate crew station member, the user is not required to duplicate the seat data for each crew station member data base in which the seat may be used. The use of *ERASE* and *NONE* in the third column will be explained in the following instructions and examples.

EXAMPLE: Select A7E-01

RESULT: The CRT displays the crew station in the display area, the member name in the information area, and the function select prompt (Figure 4.2) in the prompting area. The user may proceed to another function by depressing the required PFK, or

- 1) choose to superimpose crew stations;
- 2) change the crew station to be displayed;
- 3) remove the crew station(s) from the screen and display the man-model only.

To do any of the three listed choices, the user must recall the Retrieve Crew Station function when the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 5 to recall the Retrieve Crew Station function.

RESULT: The screen will display the Crew Station Member menu and prompt (see Figure 4.1).

PROMPT: SELECT CREW STATION MEMBER

ACTION: To superimpose crew stations, select another crew station member name from the menu.

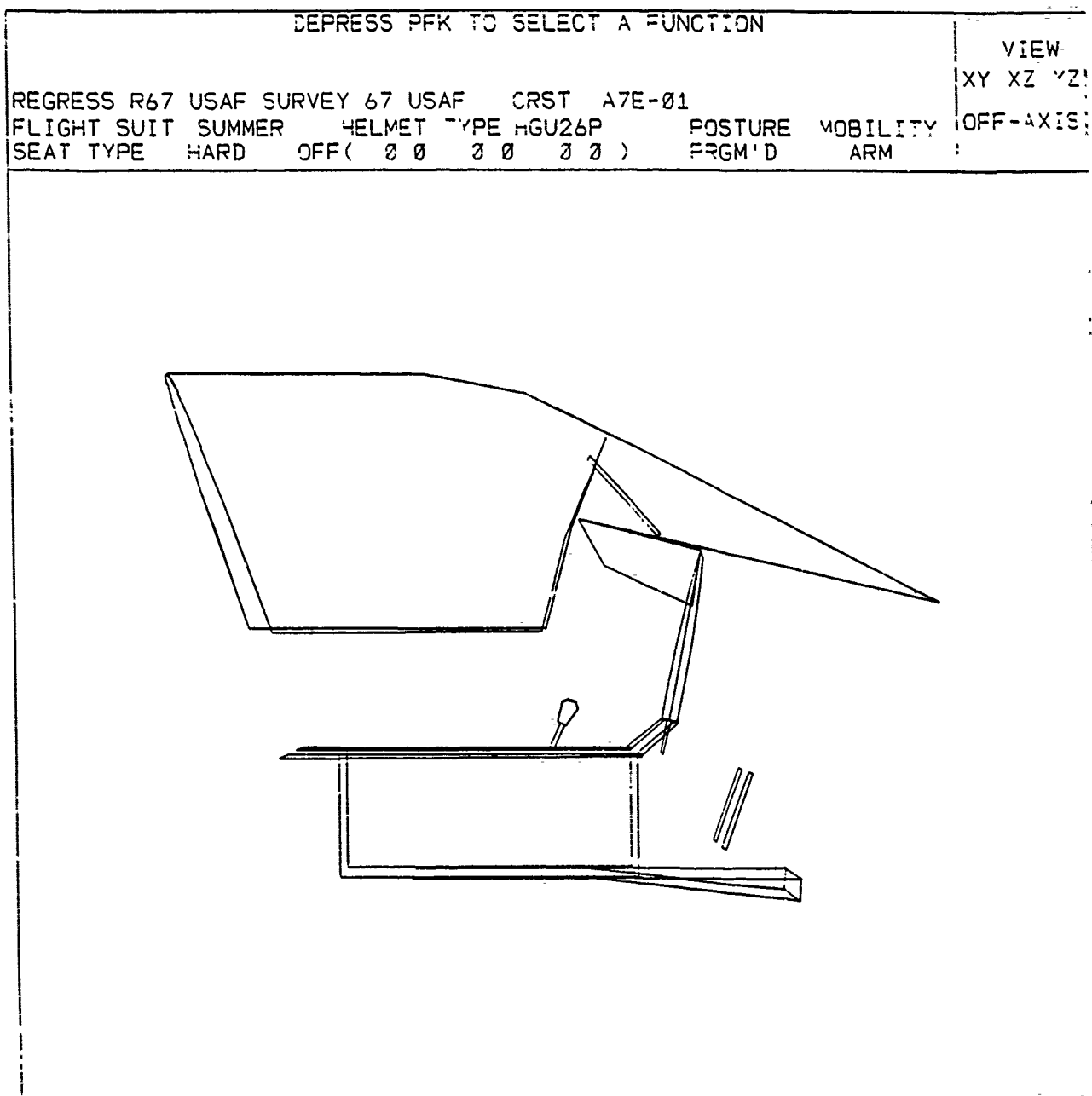


Figure 4.2. A7E-01 Crew Station

OR:

To change crew stations, select *ERASE*, and then select another crew station member name from the menu.

OR:

- To erase the crew station(s) from the screen, select *ERASE* and then *NONE*.

EXAMPLE: Select A7--SEAT

RESULT: The superimposed crew stations appear in the display area, with the last member name selected in the information area and the Function Select prompt appears (Figure 4.3).

NOTE: Although it will not happen with the example used, there is a possibility of creating an overflow condition when superimposing crew stations. This occurs when the number of "panels" or "vertices" used to design the superimposed crew stations exceeds a total of 250 or 750, respectively. If this occurs, the menu of crew station member names appears with the message "TOO MANY/PANELS VERTICES *RETRY~". The last crew station member selection (one which caused the overflow condition) is automatically canceled by the program. The user may select another crew station member, and if it does not cause an overflow condition, all crew station members selected will appear superimposed on the screen with the Function Select prompt. If another crew station is not desired, select *NONE*. All crew station members selected prior to the selection causing the overflow condition appear superimposed on the screen and the function ends.

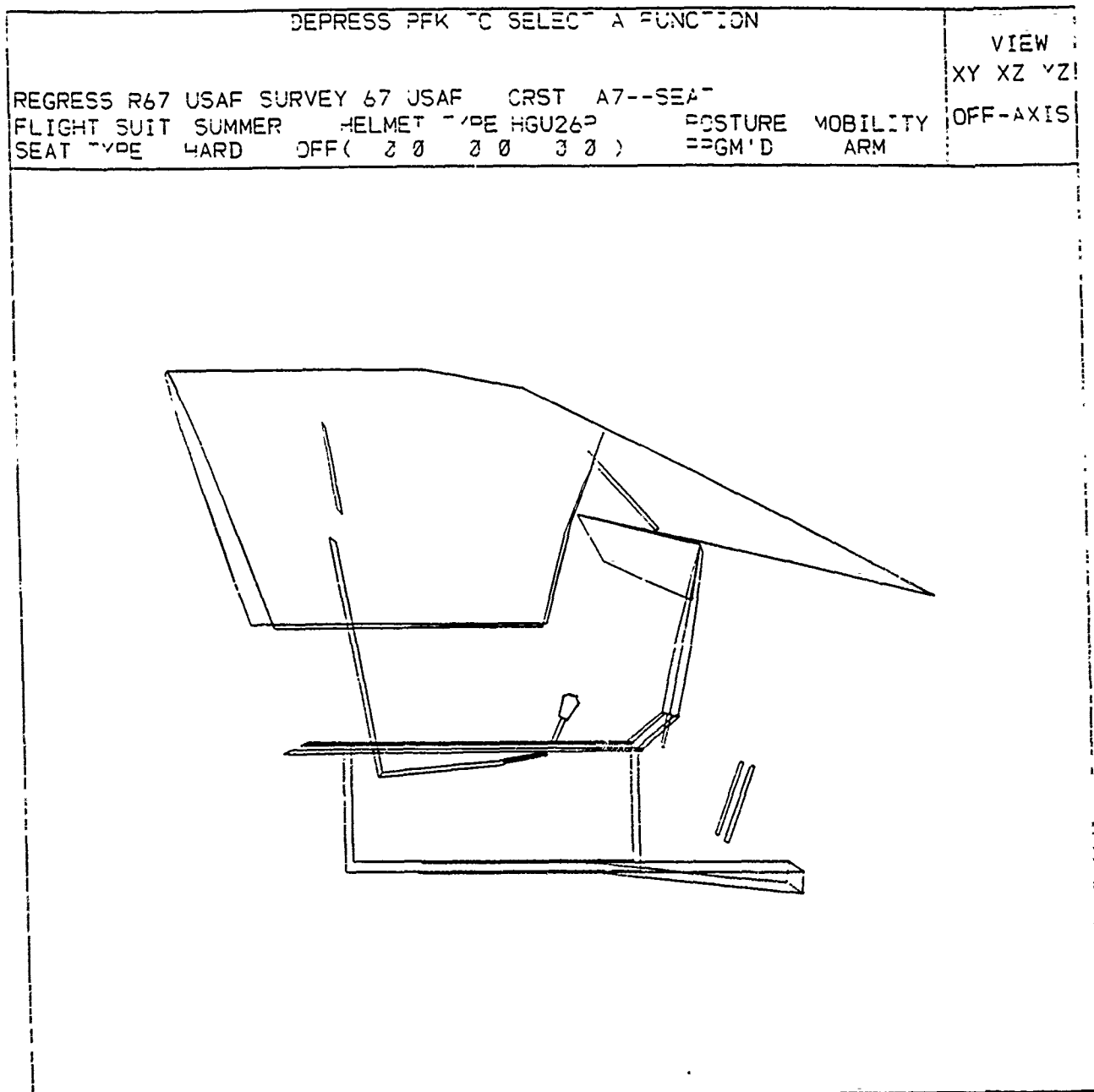


Figure 4.3. A7E-01 and A7--SEAT Crew Station Members
Superimposed in the Display

4.2 SEAT ADJUST FUNCTION (PFK 27)

The Seat Adjust function can be used to position the man-model, without a seat; the seat, without the man-model; or the man-model and the seat together; relative to the crew station SRP. This is done by establishing offset values to the neutral SRP ($X = 0$, $Y = 0$, $Z = 0$). One example of the use of this function is placing the man-model and/or seat in different positions in a multi-operator crew station. A crew station must be displayed on the screen to call the function.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 27 to call the Seat Adjust function.

RESULT: The next prompt appears (Figure 4.4).

PROMPT: ENTER X-COORDINATE OFFSET

ACTION: Enter the value for the X-coordinate offset.

- Enter X value in inches on the ANKB, followed by <CR> (Positive value for Forward, Negative value for Aft).

OR:

- Depress <CR> only for default value of 0 inches.

EXAMPLE: Enter + 25, followed by <CR>

RESULT: The next prompt appears.

PROMPT: ENTER Y-COORDINATE OFFSET

ACTION: Enter the value for the Y-coordinate offset.

- Enter Y value in inches on the ANKB, followed by <CR> (Positive value for Left, Negative value for Right).

ENTER X-COORDINATE OFFSET										VIEW		
										XY	XZ	YZ
REGRESS R67	USAF	SURVEY 67	USAF	CRST	47--SEAT							
FLIGHT SUIT	SUMMER	HELMET	TYPE	HGU26P	POSTURE	MOBILITY	OFF-AXIS					
SEAT TYPE	HARD	OFF	(	0 0	0 0	0 0	)	PRGM'D	ARM			

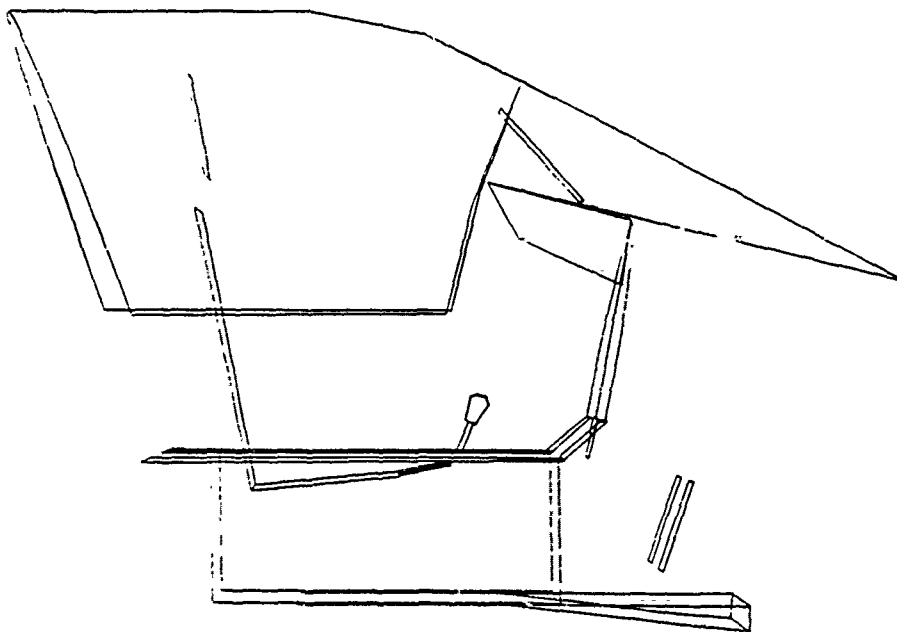


Figure 4.4. ENTER X-COORDINATE OFFSET

OR:

- Depress <CR> only for default value of 0 inches.

EXAMPLE: Depress <CR> to enter default value of 0 inches.

RESULT: The next prompt appears.

PROMPT: ENTER Z-COORDINATE OFFSET

ACTION: Enter the value for the Z-coordinate offset.

- Enter Z value in inches on the ANKB, followed by <CR> (Positive value for Up, Negative value for Down).

OR:

- Depress <CR> only for default value of 0 inches.

EXAMPLE: Enter - 50, followed by <CR>.

RESULT: The screen displays the crew station with the man-model and/or seat in the offset position. The X, Y and Z coordinate offset values appear in the Information Area of the CRT (Figure 4.5). The function ends.

If you want to return the seat, and/or the man-model, to the neutral SRP (X = 0, Y = 0, Z = 0) call the Seat Adjust function (PFK 27) when both the crew station and the function select prompt appear. Each time the "ENTER *-COORDINATE" prompt appears depress the <CR> key. The offset values will return to the default values (0).

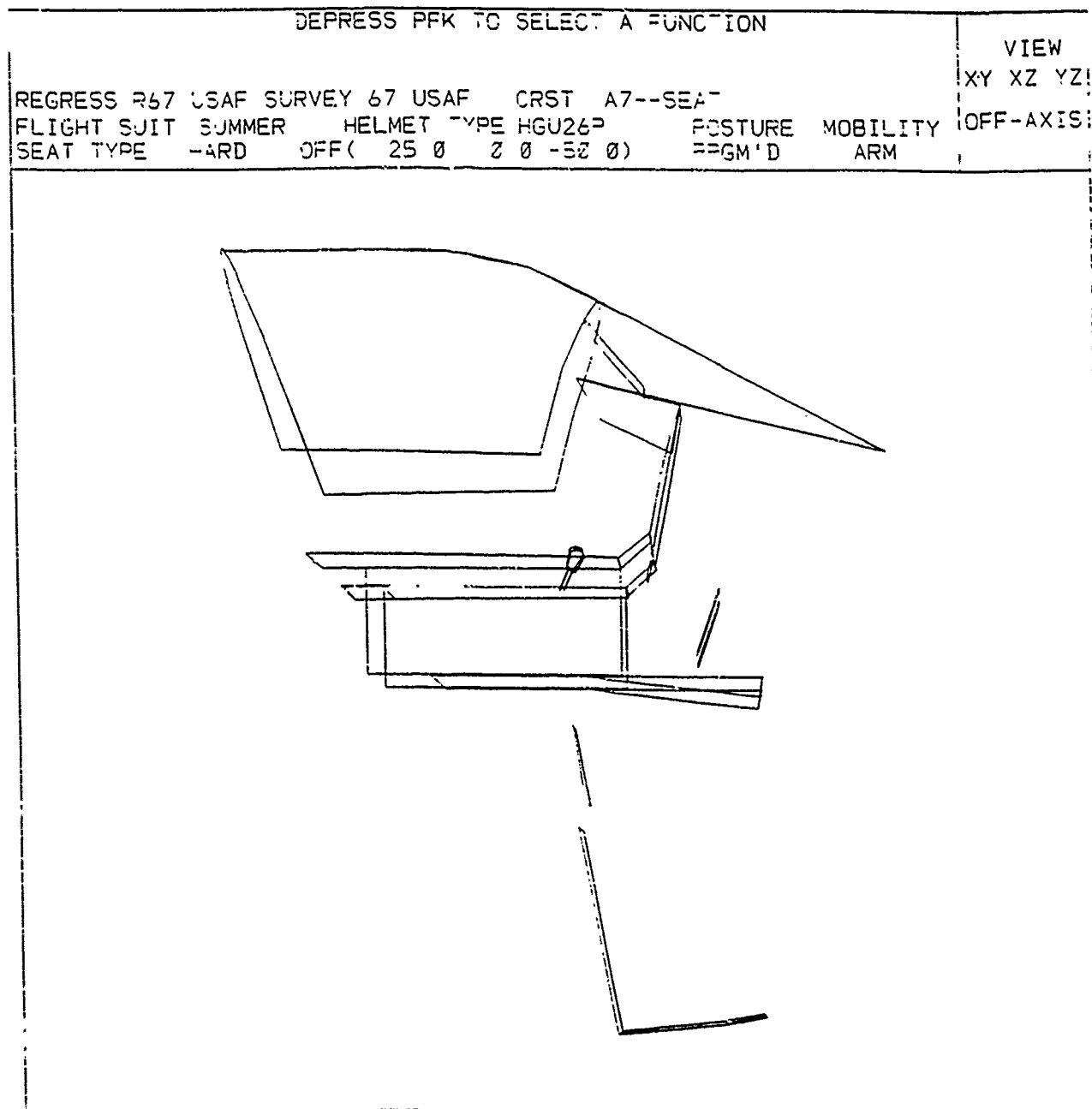


Figure 4.5. A7--SEAT in Offset Position.

4.3 DELETE PANEL FUNCTION (PFK 18)

The Delete Panel function temporarily removes a crew station panel from the display and plots. The panel definition is retained in the permanent Crew Station Data Base. To replace the panel in the display and plots, the crew station member must be recalled by executing the "Retrieve Crew Station" function (PFK 5). The Delete Panel function may be called when the function select prompt and a crew station appear on the screen.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 18 to call Delete Panel function.

RESULT: The next prompt appears (Figure 4.6).

PROMPT: SELECT PANEL YOU WANT TO DELETE

ACTION: Select the panel to be deleted.

EXAMPLE: Select the Heads Up Display (1 in Figure 4.6).

RESULT: Crew station is displayed with the selected panel deleted and the next prompt appears (Figure 4.7).

PROMPT: ARE YOU SURE?
YES NO

ACTION: Select one of the two choices.

- Select "YES" if the panel removed from the display is the one you wanted to delete.

OR:

- Select "NO" if the wrong panel was selected for deletion.

EXAMPLE: Select YES

RESULT: The function ends, and the panel is deleted during the rest of the work session, unless the crew station is recalled with the Retrieve Crew Station function (PFK 5). With a "NO" selection, the deleted panel is restored to the display and the function ends.

SELECT PANEL YOU WANT TO DELETE										VIEW
REGRESS R67 USAF SURVEY 67 USAF	CRST	A7--SEA								XY XZ YZ
FLIGHT SUIT SUMMER	HELMET TYPE HGU26P	POSTURE	MOBILITY	OFF-AXIS						
SEAT TYPE	HARD	OFF(	Ø Ø	Ø Ø	Z Ø)	==GM'D	ARM			

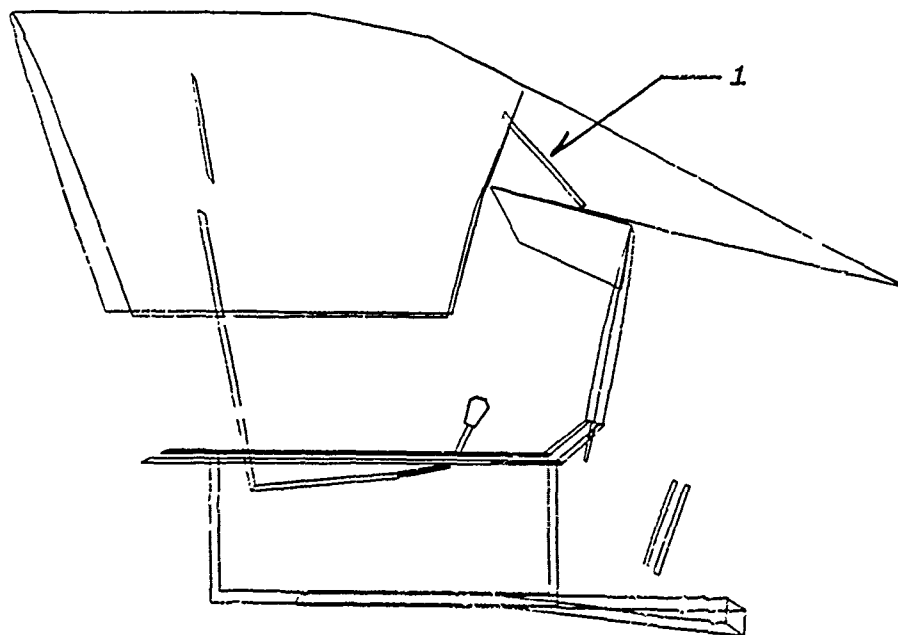


Figure 4.6. SELECT PANEL to Delete.

ARE YOU SURE ?										VIEW		
YES NO										XY XZ YZ		
REGRESS R67 USAF SURVEY 67 USAF CRST A7--SEA												
FLIGHT SUIT SUMMER HELMET TYPE HGU26P POSTURE MOBILITY OFF-AXIS												
SEAT TYPE HARD OFF(0 0 0 0 2 0) ==GM'D ARM												

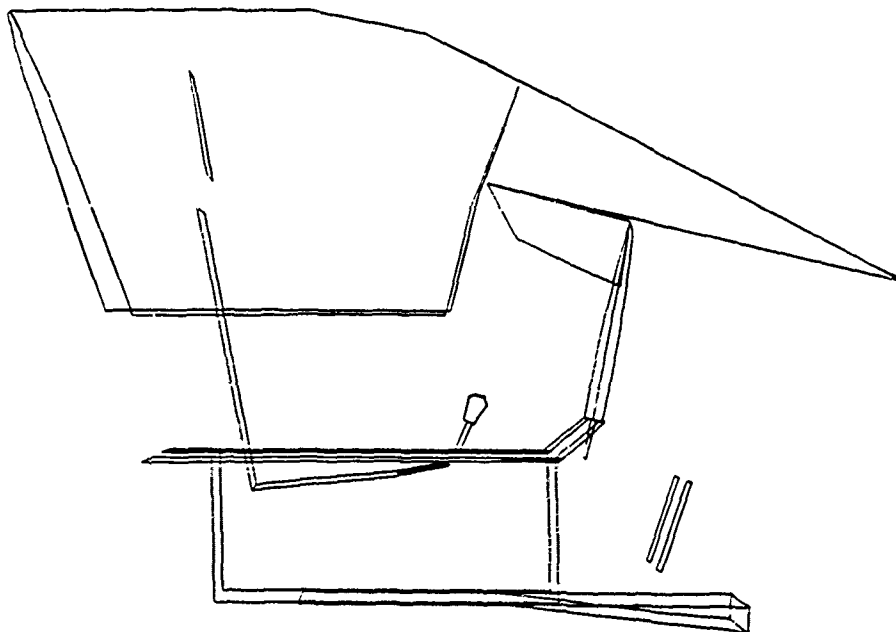


Figure 4.7. ARE YOU SURE?

4.4 DESIGN PANEL FUNCTION (PFK 16)

The Design Panel function allows the user to temporarily, or permanently, add a panel to an existing crew station while working at the CRT. The alternative is to enter panel geometry using the Crew Station Data Base Maintenance program described in Appendix B.

The Design Panel function cannot be used to enter an entire crew station from scratch via the CRT work station. This is because the member name, the X, Y and Z coordinates of the Seat Reference Point, and the positive directions of the X, Y and Z axes must be initialized through the Crew Station Data Base Maintenance program described in Appendix B. The Crew Station Data Base Maintenance program is more efficient for entering an entire crew station, where the Design Panel function is more efficient for editing or making small changes to a crew station. The function may be called at any time the function select prompt appears and a crew station member name has been selected with the Retrieve Crew Station function (PFK 5).

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 16 to call the Design Panel function.

RESULT: The next prompt appears.

PROMPT: ENTER PANEL NAME

ACTION: Enter a panel name (up to 8 characters) on the ANKB, followed by <CR>.

EXAMPLE: Enter NEWPNL, followed by <CR>.

RESULT: Panel name is entered into the program and the next prompt appears.

PROMPT: SELECT PANEL TYPE
 CLOSED OPEN SEAT PEDAL

ACTION: Select the appropriate choice from the four
 selections.

- Select CLOSED for a panel in which the first and last vertices of the panel are automatically connected.

OR:

- Select OPEN for a panel in which the first and last vertices of the panel are not connected. The depiction of a curved canopy surface is an example of when OPEN panels could be used. The resolution required for an accurate portrayal of the canopy shape can require more than the 25 vertices allowed for one panel. The solution is a series of connecting OPEN panels. The coordinates of the last vertex of a panel and the first vertex of the connecting panel would be the same.

OR:

- Select SEAT to designate closed panels that make up the crew station seat. The program uses the SEAT designation to maintain the placement of seat panels relative to each other when using the Seat Adjust function (PFK 27).

OR:

- Select PEDAL to designate closed panels that define a rudder/brake pedal. The PEDAL type designation is required, as the program internally uses this panel type designation for proper alignment of the foot and rudder/brake pedal in the Perform Reach and Strength analysis functions.

EXAMPLE: Select CLOSED

RESULT: The next prompt appears.

PROMPT: KEY IN NUMBER OF VERTICES

ACTION: Enter the number of vertices (1 to 25) used for the panel on the ANKB, followed by <CR>.

EXAMPLE: Enter 4, followed by <CR>

RESULT: The side view (X-Z plane) of the crew station appears on the screen, with the movable cursor symbol (+) positioned at the Seat Reference Point

(SRP). The Programmable Function Keyboard (PFK) is redefined, with the keys illuminated as shown in Figure 4.8, and the next prompt appears.

PROMPT: POSITION VERTEX

ACTION: The vertex is positioned with the movable cursor "+" by depressing illuminated keys on the PFK. A detailed explanation of positioning the cursor is contained in paragraph 7.1 (PFK 11).

EXAMPLE: Position the cursor RIGHT and UP until the coordinate values $X = 23.30$, $Z = 21.30$ appear on the display, and then depress PFK 31 (RECORD).

RESULT: The crew station display changes to the front view (Y-Z), with the cursor in the same position, to set the Y coordinate value of the vertex. The prompt remains the same.

PROMPT: POSITION VERTEX

ACTION: Define the Y coordinate value of the first vertex by moving the cursor to the desired position.

EXAMPLE: Enter Y coordinate value of 0 by depressing PFK 31 (RECORD)

RESULT: Display changes to the side view, with the cursor located at the position of the first vertex, to position the second vertex. The prompt remains the same.

PROMPT: POSITION VERTEX

ACTION: Repeat the procedure until all of the vertices have been positioned.

EXAMPLE: Enter the coordinate values for;

the second vertex, $X = 22.40$, $Y = 0.0$ and $Z = 15.30$
the third vertex $X = 22.40$, $Y = 7.00$ and $Z = 15.30$
the fourth vertex, $X = 29.40$, $Y = 7.00$ and $Z = 13.30$

RESULT: As each vertex position is defined, the screen displays the line connecting it to the preceding vertex. If the panel is CLOSED, the last vertex is automatically connected to the first vertex (Figure 4-9). The function ends.

COMBIMAN
VERSION 8

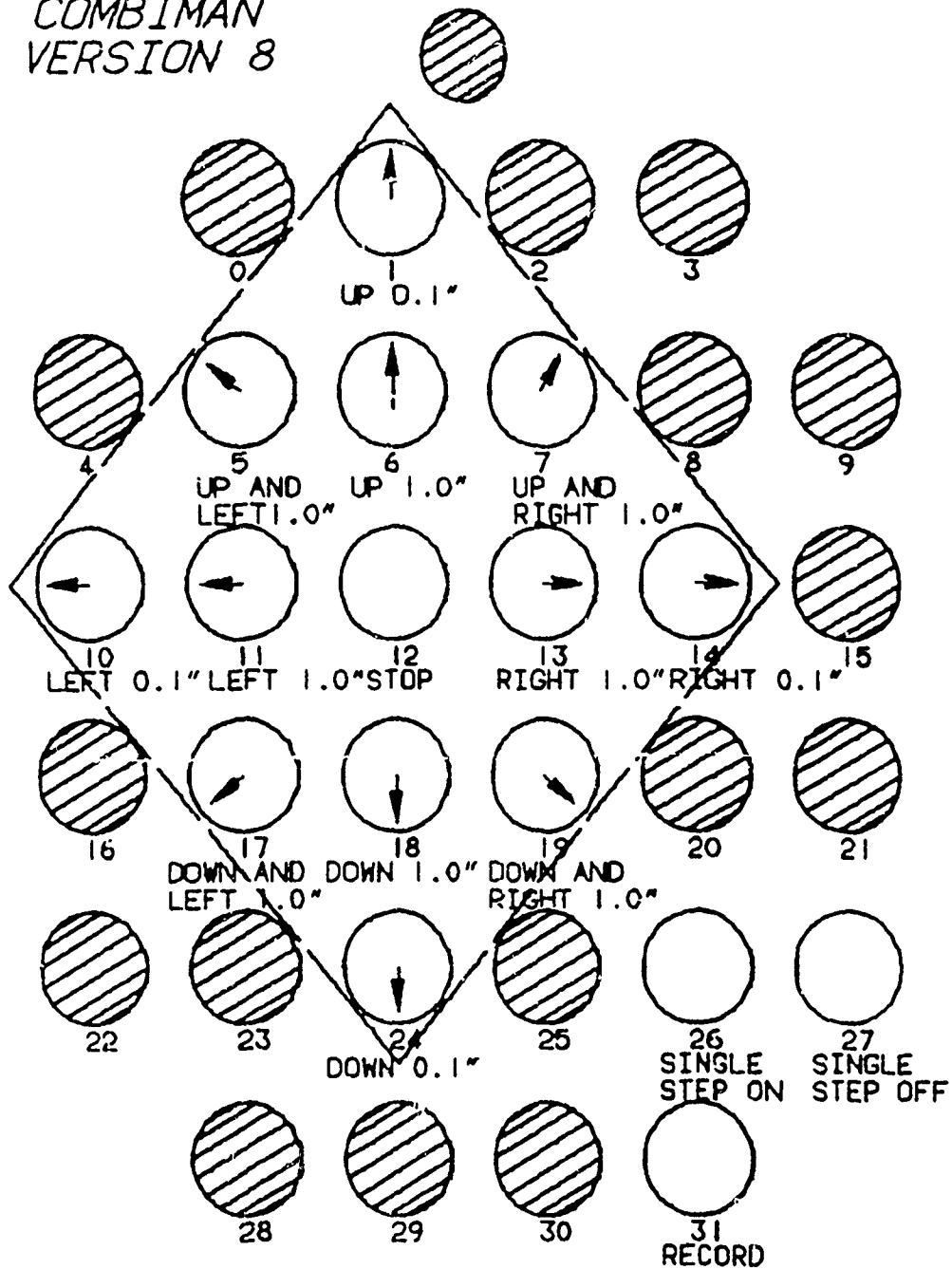
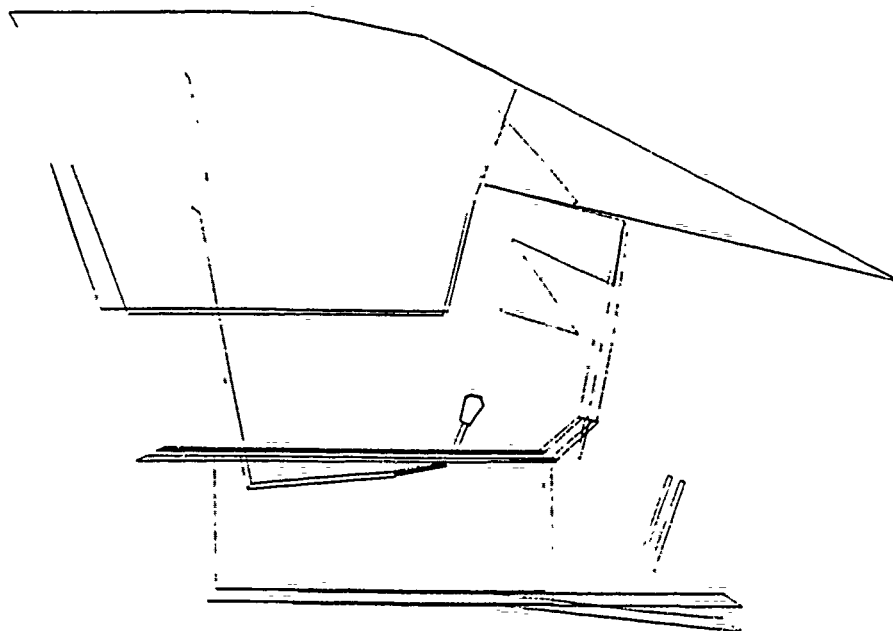


Figure 4.8. Redefined Program FUNCTION Keys for Positioning the "+" Symbol. Shaded keys are not used or illuminated.

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7-3

Once the panel is defined it can be treated as any other panel in the display. It can be removed during the session by exercising the "ERASE" option of the Retrieve Crew Station function (PFK 5), or by activating either the Restart COMBIMAN (PFK 30) or the End COMBIMAN (PFK 31) function. Or the panel may be deleted using the Delete Panel function (PFK 18), as the panel definition data are not automatically added to the permanent Crew Station Data Base.

You can add the designed panel to the permanent Crew Station Data Base with the Save Current Crew Station function (PFK 10). When the End COMBIMAN function (PFK 31) is activated the name and coordinate data will be printed as shown in Figure 4.10. These data can be used to enter the panel in the permanent Crew Station Data Base with the input card method described in Appendix B.

CBM033I REGRESSION VALUES FROM MEMBER R67 USAF.

CBM015I SURVEY DATA FROM 67 USAF

CBM045I USER INPUTS 2 INDEPENDENT VARIABLES

CBM041I INPUT VARIABLES ARE IN PERCENTILES

SITTING HEIGHT 40 PCT 36.33 IN

WEIGHT 45 PCT 169.74 LB

COMPUTED ANTHROPOMETRIC DIMENSIONS

NO.	VARIABLE NAME	VALUE	UNIT
-----	---------------	-------	------

1	WEIGHT	169.74	LB
---	--------	--------	----

2	SITTING HEIGHT	36.33	IN
---	----------------	-------	----

3	ACROMION HGT/SIT	23.78	IN
---	------------------	-------	----

4	KNEE HGT/SITTING	21.81	IN
---	------------------	-------	----

5	BUTTOCK-KNEE LGTH	23.66	IN
---	-------------------	-------	----

6	SHOULDR-ELB LGTH	14.06	IN
---	------------------	-------	----

7	BIACROMIAL BRDTH	15.94	IN
---	------------------	-------	----

8	HIP BREADTH	13.77	IN
---	-------------	-------	----

9	CHEST DEPTH	9.59	IN
---	-------------	------	----

10	FOOT LENGTH	10.57	IN
----	-------------	-------	----

11	HAND LENGTH	7.48	IN
----	-------------	------	----

12	ELBOW-WRIST LGTH	11.74	IN
----	------------------	-------	----

CBM014I C/S DATA FROM A7E-01

CBM007I 82. PANEL NAME: NEWPNL , TYPE= 1, 4 VERTICES

23.30	0.0	21.30	22.40	0.0	15.30	22.40	7.00	15.30	29.40	7.00	13.30
-------	-----	-------	-------	-----	-------	-------	------	-------	-------	------	-------

CBM048I DATA WRITTEN FOR OFF-LINE PLOT NO. 1.

CBM048I DATA WRITTEN FOR OFF-LINE PLOT NO. 2.

Figure 4.10. Printed Output of the Newly Designed Panel
NEWPNL is Within the Box.

4.5 SAVE CURRENT CREW STATION FUNCTION (PFK 10)

The Save Current Crew Station function is used to save modifications made on the display, change the coordinate system in the crew station data base, or delete a crew station from the crew station data base. Prior to using this function, a crew station member must have been selected with the Retrieve Crew Station function (PFK 5) and be displayed on the screen. The function allows the user to:

1. save a crew station which was modified on the CRT work station by adding or deleting panels. Being able to save the crew station in its current configuration has two distinct advantages. First, when temporary changes are made during a work session, that particular configuration may be directly recalled in a later work session, rather than having to reconstruct the configuration. Second, if changes are permanent and the configuration is saved to the Crew Station Data Base with this function, data cards do not have to be coded/re-coded for each deleted, or added, panel.
2. change the user defined coordinate system. When a crew station is initiated (reference Appendix B), the user defines the X, Y and Z coordinates of the Seat Reference Point (SRP) and the direction of the positive axes of the coordinate system (usually corresponding to the aircraft coordinate system). The program transforms the data to the COMBIMAN coordinate

system. The data printed out, or presented, during a working session can be either in the COMBIMAN, or user defined, coordinate system as determined by the ON/OFF status of State Switch 10 in the State Switch function (PFK 29).

3. delete a crew station from the Crew Station Data Base.

Your distribution tape has only the A7E-01 and A7--SEAT crew station members included, so the examples used in the description of the function's operation are based on the A7--SEAT superimposed on the A7E-01 crew station. The data for these two crew stations members, as distributed, have the COMBIMAN coordinate system as the user defined coordinate system. The origin ($X = 0$, $Y = 0$, $Z = 0$) is at the Seat Reference (SRP), with the direction of the positive axes being: Forward for X, Left for Y and Up for Z.

Prior to initiating the Save Current Crew Station function, retrieve the A7E-01, and then the A7--SEAT, crew station members with the Retrieve Crew Station function (PFK 5). The name of the last crew station selected, in this case A7--SEAT, appears in the Information area of the screen. The man-model may be removed from the display with State Switch 5 of the State Switch function (PFK 29). The function select prompt appears in the prompting area.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK10 to call the Save Current Crew Station function.

RESULT: The function is activated and the first prompt and selection menus appear in the screen display area (Figure 4.11).

PROMPT: SELECT ACTION FOR CREW STATION

ACTION: Select one of the three choices.

- Select SAVE A CREW STATION if you want to save the current on screen configuration or change the user defined coordinate system.

OR:

- Select DELETE A CREW STATION if you want to delete an existing crew station from the Crew Station Data Base.

OR:

- Select EXIT if you want to end the function without further action.

RESULT: The result depends on which choice is made. If EXIT is chosen the function ends and the function select prompt appears. Since there is considerable variance in the results of the other two selections, both will be explained in the following paragraphs.

4.5.1 SAVE A CREW STATION Selected

RESULT: The next prompt appears in the display area.

PROMPT: ENTER MEMBER NAME TO BE SAVED TO:
8 CHARACTERS MAXIMUM

ACTION: Enter the desired crew station member name on the ANKB, followed by <CR>.

EXAMPLE: Enter A7-ALL, followed by <CR>.

RESULT: There are two possible results, depending on the crew station member name selected. If you have selected an existing crew station member name the screen will display the following message:

DELETE AND REWRITE (member name entered)?
YES NO

										VIEW
										XY XZ YZ
REGRESS R67 USAF SURVEY 67 USAF	CRST	A7--SEAT								
FLIGHT SUIT SUMMER	HELMET TYPE	HGU26P	POSTURE	MOBILITY						OFF-AXIS
SEAT TYPE	HARD	OFF(	0 0	0 0	2 0)	FGM'D	ARM			
SELECT ACTION FOR CREW STATION										
SAVE A CREW STATION										
DELETE A CREW STATION										
EXIT										

Figure 4.11. Selections for the Save Current Crew Station function.

A NO selection ends the function.

A YES selection continues the function and the existing crew station member is deleted from the Crew Station Data Base and replaced with the current crew station. The next prompt and menu appear in the display area (Figure 4.12).

PROMPT: At bottom of display area.

IF SRP COORDINATES ARE WRONG: SELECT (CHANGE SRP)

IF AXES DIRECTIONS ARE WRONG: SELECT (CHANGE DIRECTIONS)

IF COORDINATES AND DIRECTIONS ARE RIGHT: SELECT (EXECUTE)

The existing Seat Reference Point (SRP) coordinate values are displayed at the top of the screen, and the existing positive axes under the ORIGINAL AXES column.

ACTION: Select one of the three choices.

- Select (CHANGE SRP) if you desire to change the SRP coordinate values.

OR:

- Select (CHANGE DIRECTIONS) to change any, or all, of the axes positive directions.

OR:

- Select (EXECUTE) if no changes are to be made in either the SRP coordinate values or the axes positive directions.

EXAMPLE 1: Select (CHANGE SRP) (Reference Paragraph B.3.1)

RESULT: Screen display is configured with the next prompt (Figure 4-13).

PROMPT: ENTER X COORDINATE POINT FOLLOWED BY RETURN
(bottom prompt)

ACTION: Enter the SRP coordinate value for the user defined coordinate system.

EXAMPLE: Enter 277.17, followed by <CR>.

CHANGE CREW STATION COORDINATE SYSTEM

SEAT REFERENCE POINT

X Y Z
(0 0 , 0 0 , 0 0)

DIRECTION OF AXES

ORIGINAL AXES

DIRECTION OF POSITIVE X AXIS	-	FORWARD
DIRECTION OF POSITIVE Y AXIS	-	LEFT
DIRECTION OF POSITIVE Z AXIS	-	UP

(*CHANGE SRP*) (*CHANGE DIRECTIONS*) (*EXECUTE*)

IF SEAT REFERENCE POINT IS INCORRECT SELECT (*CHANGE SRP*)
IF AXES DIRECTIONS ARE WRONG SELECT (*CHANGE DIRECTIONS*)
IF SRP AND AXES ARE CORRECT SELECT (*EXECUTE*)

Figure 4.12. Selections for Changing SRP Coordinates or Axes Positive Directions.

CHANGE CREW STATION COORDINATE SYSTEM

SEAT REFERENCE POINT

X Y Z
_ (, ,)

DIRECTION OF AXES

ORIGINAL AXES

DIRECTION OF POSITIVE X AXIS	-	FORWARD
DIRECTION OF POSITIVE Y AXIS	-	LEFT
DIRECTION OF POSITIVE Z AXIS	-	UP

ENTER X COORDINATE POINT FOLLOWED BY RETURN

Figure 4.13. ENTER X COORDINATE POINT FOLLOWED BY RETURN

RESULT: The value entered appears under the X column on the screen and the next prompt appears.

PROMPT: ENTER Y COORDINATE POINT FOLLOWED BY RETURN
(bottom prompt)

ACTION: Enter the SRP Y coordinate value for the user defined coordinate system.

EXAMPLE: Enter 0.01, followed by <CR>.

RESULT: The value entered appears under the Y column and the next prompt appears.

PROMPT: ENTER Z COORDINATE POINT FOLLOWED BY RETURN
(bottom prompt)

ACTION: Enter the SRP Z coordinate value for the user defined coordinate system.

EXAMPLE: Enter 95.35, followed by <CR>.

RESULT: The value entered appears under the Z column. The screen reverts to the display shown in Figure 4.12.

EXAMPLE 2: Select (CHANGE DIRECTIONS) (Reference Para B.3.1)

RESULT: Screen displays a SELECT indicator to the left of the "DIRECTION OF POSITIVE X AXIS" line, with the possible directions listed (Figure 4.14). The original axis direction stays under the ORIGINAL AXIS column.

PROMPT: SELECT DIRECTION OF X AXIS (bottom prompt)

ACTION: Select one of the six listed directions.

EXAMPLE: Select AFT.

RESULT: The direction selected appears to the right of the "DIRECTION OF POSITIVE X AXIS" line. The set of associated directions (FORWARD and AFT) is erased and the SELECT indicator moves to the next line.

PROMPT: SELECT DIRECTION OF Y AXIS (bottom prompt)

ACTION: Select one of the four possible directions listed.

CHANGE CREW STATION

COORDINATE SYSTEM

SEAT REFERENCE POINT

X	Y	Z
(277 17	, 0 01	, 95 35)

DIRECTION OF AXES

ORIGINAL AXES

SELECT DIRECTION OF POSITIVE X AXIS	-	FORWARD
DIRECTION OF POSITIVE Y AXIS	-	LEFT
DIRECTION OF POSITIVE Z AXIS	-	UP

---POSSIBLE DIRECTIONS---

FORWARD	LEFT	UP
AFT	RIGHT	DOWN

SELECT DIRECTION OF X AXIS

Figure 4.14. SELECT DIRECTION OF THE POSITIVE X AXIS

EXAMPLE: Select RIGHT.

RESULT: The direction selected appears to the right of the "DIRECTION OF POSITIVE Y AXIS" line. The associated directions (RIGHT and LEFT) are erased and SELECT indicator moves to next line.

PROMPT: SELECT DIRECTION OF Z AXIS (bottom prompt)

ACTION: Select one of the two possible directions listed.

EXAMPLE: Select UP.

RESULT: The direction selected appears to the right of the "DIRECTION OF POSITIVE Z AXIS" line. The screen displays the current SRP coordinate values and positive axes directions (Figure 4.15). Changes may be made in either the SRP coordinate values or positive axes directions until "EXECUTE has been selected.

PROMPT: IF COORDINATES AND DIRECTIONS ARE RIGHT: SELECT (EXECUTE)

ACTION: Select (EXECUTE).

RESULT: The function executes and the data are written to, and saved in, the Crew Station Data Base. The program internally checks for storage space and, if required, compresses the data base. The screen periodically flashes the message "COMPRESSING" while this process is in progress. If there is insufficient storage space after the compressing process is completed, the screen displays the message "DISK FULL" and the function ends. See your systems management personnel for instructions. If no space problems are encountered, the crew station is saved and the function ends.

4.5.2 DELETE A CREW STATION Selected

When "DELETE A CREW STATION" is selected, the screen lists all the crew station member names in the Crew Station Data Base, the term *EXIT*, and the next prompt (Figure 4.16).

PROMPT: SELECT CREW STATION MEMBER

ACTION: Select one of the listed member names or *EXIT*.

EXAMPLE: Select A7-ALL.

CHANGE CREW STATION

COORDINATE SYSTEM

SEAT REFERENCE POINT

X Y Z
- (277 17 , 0 01 , 95 35)

DIRECTION OF AXES

ORIGINAL AXES

DIRECTION OF POSITIVE X AXIS	- AFT	FORWARD
DIRECTION OF POSITIVE Y AXIS	- RIGHT	LEFT
DIRECTION OF POSITIVE Z AXIS	- UP	UP

(*CHANGE SRP*) (*CHANGE DIRECTIONS*) (*EXECUTE*)

IF SEAT REFERENCE POINT IS INCORRECT SELECT (CHANGE SRP)
IF AXES DIRECTIONS ARE WRONG SELECT (CHANGE DIRECTIONS)
IF SRP AND AXES ARE CORRECT SELECT (EXECUTE)

Figure 4.15. Current SRP Coordinate Values
and Positive Axes Directions.

SELECT CREWSTATION MEMBER

CREW STATION MEMBER

A7-ALL

A7--SEAT

A7E-01

EXIT

Figure 4.16. Select Crew Station Member for Deletion

RESULT: The next prompt appears. If *EXIT* is selected the function would end, with no deletion of crew stations.

PROMPT: CONTINUE TO DELETE A7-ALL?
YES NO

ACTION: Select one of the two choices.

- Select YES to delete the A7-ALL crew station.

OR:

- Select NO to end the function and retain the A7-ALL in the Crew Station data base.

EXAMPLE: Select YES.

RESULT: The A7-ALL crew station is deleted from the Crew Station Data Base and erased from the Select Crew Station Member menu.

ACTION: Select *EXIT* to exit the function.

RESULT: Function ends and the function select prompt appears in the prompting area.

SECTION 5

DISPLAY RELATED FUNCTIONS

Display related functions allow manipulation of the on-screen presentation: the display can be rotated on the screen; portions of the display may be magnified; and panels in the display can be identified, omitted, and included.

5.1 CHANGE VIEW FUNCTION (PFK 0)

The Change View function allows the user to select the angle from which the display is viewed. Any of three orthogonal views which are perpendicular to the XY plane (top view), the XZ plane (side view), or the YZ plane (front view) may be selected. There is also an "OFF-AXIS" view available which allows the user to enter the angles of rotation around the X, Y, and Z axes for the on-screen display. The function can be called when the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 0 to start the Change View function.

RESULT: The screen displays the crew station, and man-model if included. The next prompt appears.

PROMPT: SELECT VIEW CHANGE

ACTION: There are four views listed in the upper right-hand corner of the screen: XY, XZ, YZ, and OFF-AXIS (Figure 5.1).

- Select XY for a top view.

SELECT VIEW CHANGE												VIEW		
												XY	XZ	YZ
REGRESS R67 USAF SURVEY 67 USAF CRST A7--SEAT														
FLIGHT SUIT SUMMER HELMET TYPE -G026P POSTURE MOBILITY OFF-AXIS														
SEAT TYPE -ARD OFF(0 0 0 0 2 0) PRGM'D ARM														

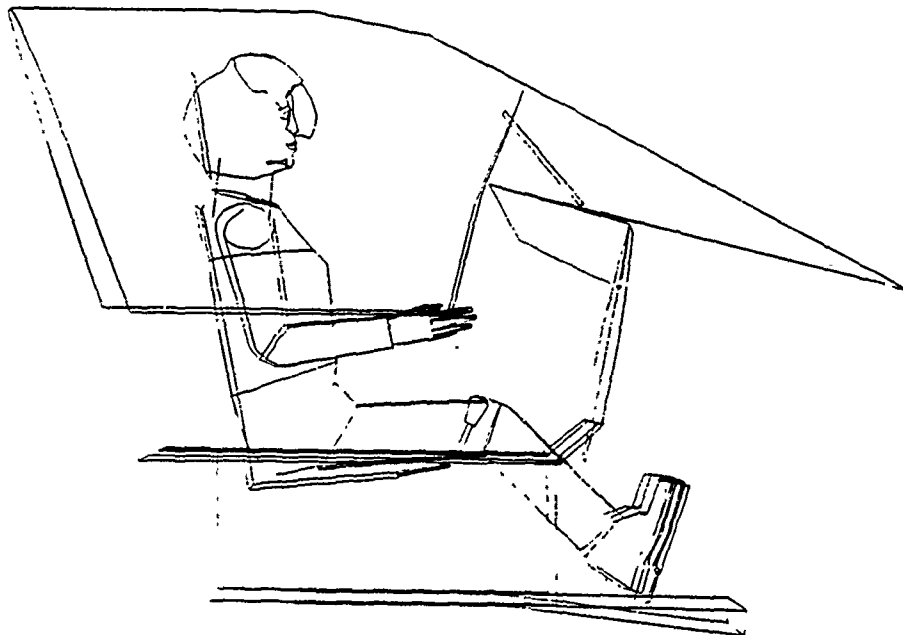


Figure 5.1. SELECT VIEW CHANGE.

OR:

- Select XZ for a side view.

OR:

- Select YZ for a front view.

OR:

- Select OFF-AXIS to select a user defined view plane.

EXAMPLE: Select OFF-AXIS

RESULT: The next prompt appears. If XY, XZ, or YZ had been selected, the screen would have displayed the man-model, and/or crew station, in the view plane selected and the function would terminate. Since OFF-AXIS was selected, the following prompt appears.

PROMPT: ENTER ROLL ANGLE

ACTION: ROLL is rotation around the X-axis. Enter the desired Roll angle value (Negative for Left, Positive for Right) on the ANKB, followed by <CR>.

OR:

- If the default value (0 degrees) is desired, just depress <CR>.

EXAMPLE: Enter -15 <CR>.

RESULT: The next prompt appears.

PROMPT: Enter PITCH angle.

ACTION: PITCH is the rotation around the Y-axis. Enter the desired Pitch angle value (Negative for Nose Up, Positive for Nose Down) on the ANKB, followed by <CR>.

OR:

- If the default value (0 degrees) is desired, just depress <CR>.

EXAMPLE: Depress <CR> for default value of 0 degrees.

RESULT: Next prompt appears.

PROMPT: ENTER YAW ANGLE

ACTION: YAW is rotation around the Z-axis. Enter the desired Yaw angle value (Negative for Right, Positive for Left) on the ANKB, followed by <CR>.

EXAMPLE: Enter 15 <CR>.

RESULT: Crew station, and man-model if included, are displayed in the rotated position (Figure 5.2). The Roll, Pitch, and Yaw angle values appear in the upper right-hand corner of the display area. The function terminates and the Function Select prompt appears.

DEPRESS PEK TO SELECT A FUNCTION										VIEW		
										XY	XZ	YZ
REGRESS R67	USAF	SURVEY 67	USAF	CRST	A7--SEAT							
FLIGHT SUIT	SUMMER	HELMET	TYPE	HGU26P	PCSTURE	MOBILITY	OFF-AXIS					
SEAT TYPE	HARD	OFF(	0 0	0 0	2 0)	==GM'D	ARM					
RPY(-15 0, 0 0, 15 0)												

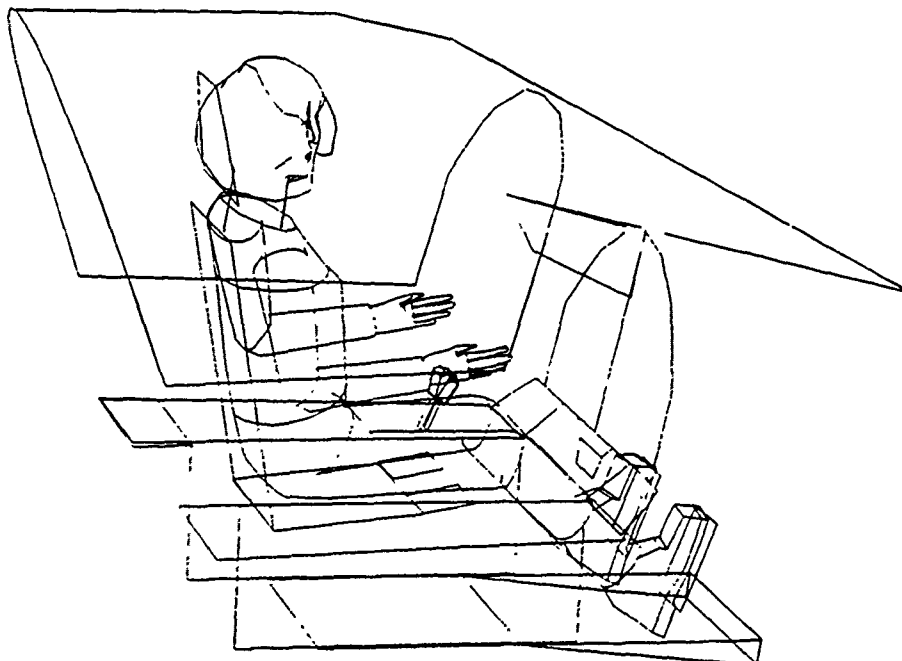


Figure 5.2. Off-Axis View. Roll Angle = -15° , Pitch Angle = 0° , Yaw Angle = 15° .

5.2. ZOOM FUNCTION (PFK 28)

The ZOOM function allows the user to "zoom-in" (magnify) a user defined portion of the COMBIMAN display area. This function may be called when the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 28 to initiate the Zoom function.

RESULT: The message "DEFINE ZOOM WINDOW" momentarily appears on the screen. Next a matrix of dots, at 0.5 inch intervals, covers the COMBIMAN display area and the next prompt appears (Figure 5.3).

PROMPT: SELECT LOWER LEFT CORNER

ACTION: Select any dot to designate the lower left hand corner of the zoom window.

EXAMPLE: Starting from the lower left corner of the display area, select the dot in the 8th row right and 8th row up.

RESULT: The limiting left and bottom lines are displayed. All dots below and left of these lines are removed from the screen and the next prompt appears (Figure 5.4).

PROMPT: SELECT UPPER RIGHT CORNER

ACTION: Select any dot to designate the upper right hand corner of the zoom window.

EXAMPLE: Starting from the lower left hand corner of the limiting lines, select the dot in the 6th row right and 6th row up.

RESULT: Remaining dots are removed from the screen and the zoom window boundaries are displayed. The display regenerates with the zoom window filling the entire display area. The next prompt appears.

SELECT LOWER LEFT CORNER										VIEW
REGRESS R67 USAF SURVEY 67 USAF	CRST	A7--SEAT								XY XZ YZ'
FLIGHT SUIT SUMMER	HELMET TYPE HGU26P	POSTURE	MOBILITY							OFF-AXIS:
SEAT TYPE HARD	OFF(0 0 0 0 2 0)	PRGM'D	ARM							

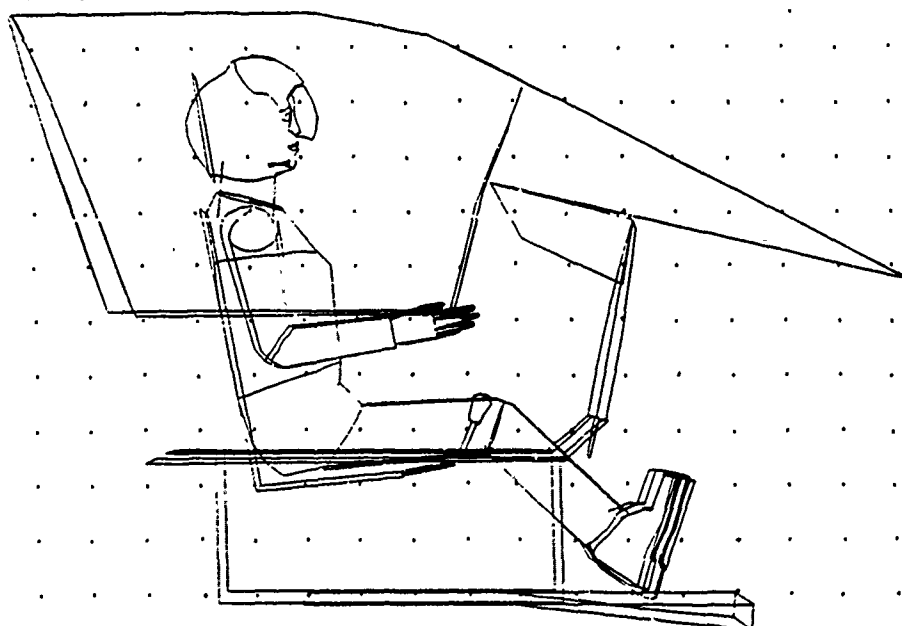


Figure 5.3. SELECT LOWER LEFT CORNER of ZOOM Window.

PROMPT: DO YOU WANT TO END ZOOM? SELECT YES OR NO
 YES NO

ACTION: Select YES or NO.

Select YES to terminate the Zoom function. The zoomed display is retained until execution of another function (such as Change View, Retrieve Anthropometry or Retrieve Crew Station) causes regeneration of the display. If State Switch 8 (reference PFK 29) is set "ON" prior to calling the Zoom function, the display returns to the normal scale when the Zoom function ends.

OR:

Select NO to repeat the ZOOM function and select another section of the current display for even closer view. The Zoom function can be repeated indefinitely by answering NO to this prompt.

EXAMPLE: Select NO

RESULT: The first prompt, "SELECT LOWER LEFT CORNER", reappears, with the matrix of dots, and the procedure for defining the zoom window is repeated.

5.3 INCREMENT ROLL, PITCH AND YAW ANGLES FUNCTION (PFK 26)

The Increment Roll, Pitch and Yaw Angles function is used to rotate the model through a series of pre-programmed rotations. The user may pause after any step to make a plot, or select another function.

The program has default values of six rotational iterations at 0 degrees Roll, -15 degrees Pitch and 15 degrees Yaw. Each time PFK 26 is depressed the display is incrementally rotated as an additive of the Roll, Pitch and Yaw angles. The user may define the number of iterations and the Roll, Pitch and Yaw angles by selecting Subfunction 2 (Reference PFK 29). The function may be called at anytime the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 26 to call the Increment Roll, Pitch and Yaw Angles function.

RESULT: The screen displays the crew station with the Roll, Pitch and Yaw for the first iteration (Figure 5.5). With the default values mentioned above the crew station will be displayed with the following rotation:

0 degrees Roll
-15 degrees Pitch
15 degrees Yaw

The function select prompt appears.

NOTE: This function may be repeated as desired. Each time PFK 26 is depressed the crew station rotates another increment. After the specified number of increments (6 in this example), the next time PFK 26 is depressed the display returns to the starting position.

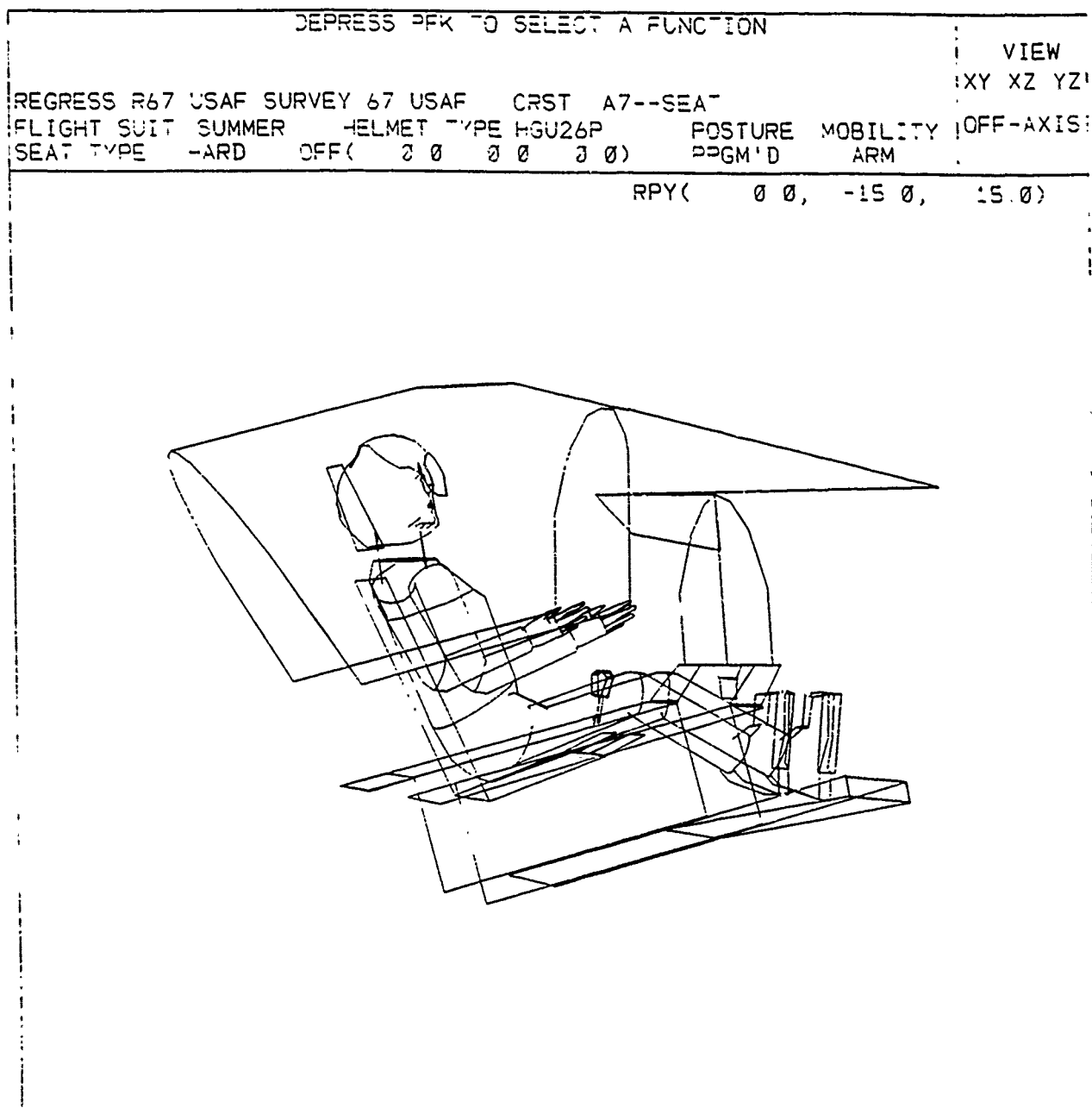


Figure 5.5. First Increment Rotation.

5.4 IDENTIFY PANEL FUNCTION (PFK 1)

The Identify Panel function displays identifying information on the CRT for any crew station panel chosen by the user. The function may be called when the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 1 to call the Identify Panel function.

RESULT: The next prompt appears (Figure 5.6).

PROMPT: SELECT PANEL TO IDENTIFY OR --> EXIT/CR

ACTION: Select panel to be identified, or <CR> to exit function.

EXAMPLE: Select the panel labeled 1 in Figure 5.6.

RESULT: The screen displays the following: (Figure 5.7).

- In the Information area:

- (1) Reference number of the panel - an integer assigned by the program which identifies the panel.
- (2) Reference coordinates for the panel - X,Y and Z coordinates of the panel's center in COMBIMAN coordinate system.
- (3) 8-character name of the panel.

- In the Display area.

- (1) Coordinates of the panel vertices - In COMBIMAN coordinate system, or in the user defined coordinate system if State Switch 8 (PFK 29) is "ON".
- (2) Prompt message.

PROMPT: DEPRESS <CR> OR
SELECT DISPLAYED COORDINATE

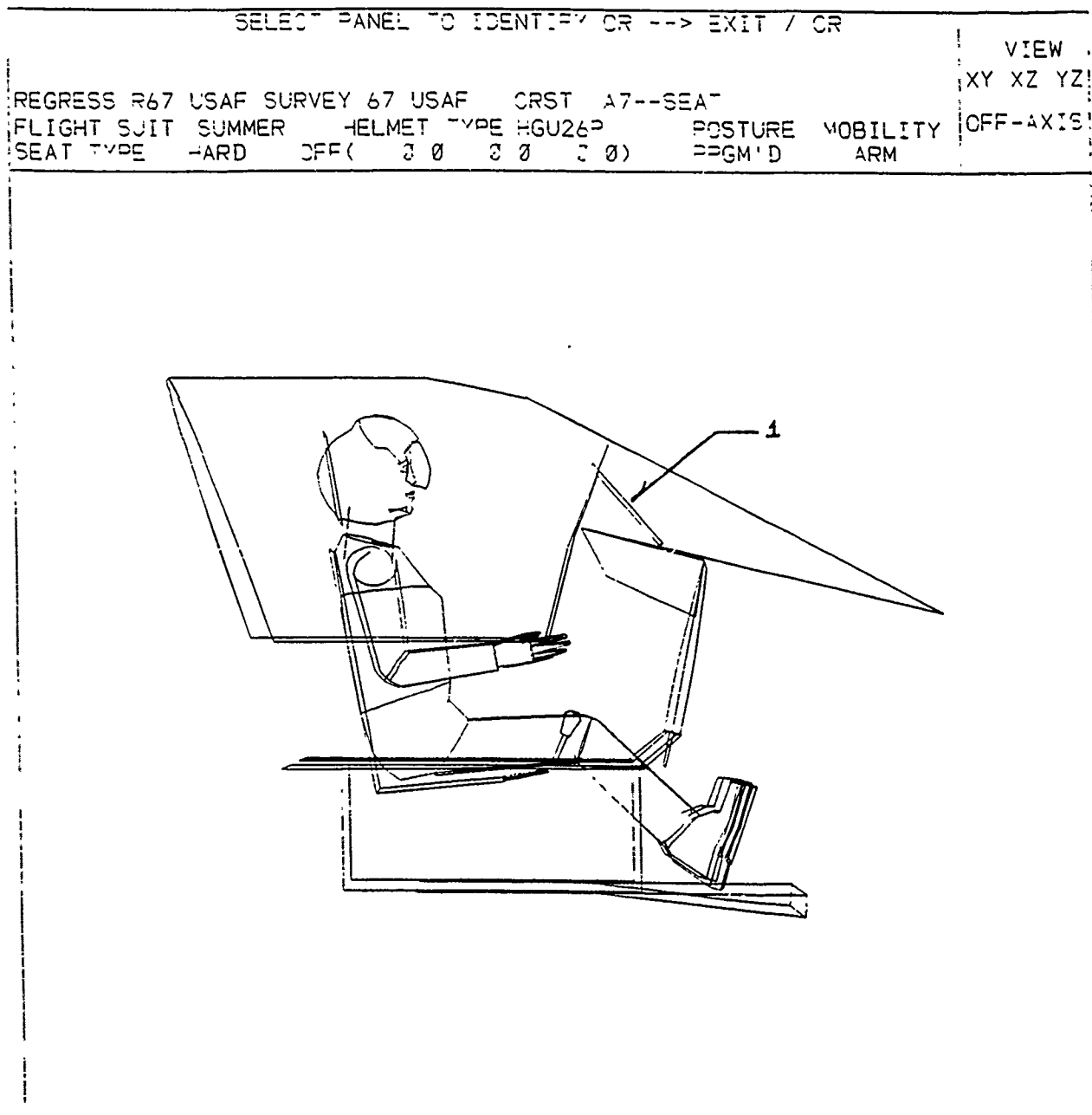


Figure 5.6. SELECT PANEL TO IDENTIFY OR --> EXIT/CR

ACTION: Select one of the two choices.

- Depress <CR> to exit the function.

OR:

- Select one of the sets of displayed coordinates.

EXAMPLE: Select the top set of coordinates.

RESULT: Selected vertex location will be indicated by a small, triangular indicator (Figure 5.8) which stays in place until another set of coordinates is selected, or <CR> is depressed to exit the function.

Figure 5.7 shows the results of performing the "Identify Panel" function on the HUD (Heads Up Display) in the A7E-01 crew station. The display in the Information Area of the CRT:

22 25.55 0.0 28.36 HUDSCRN

indicates that its reference number is 22, the COMBIMAN coordinates of the panel's center are $X = 25.55$, $Y = 0.0$, $Z = 28.36$ and its name is HUDSCRN.

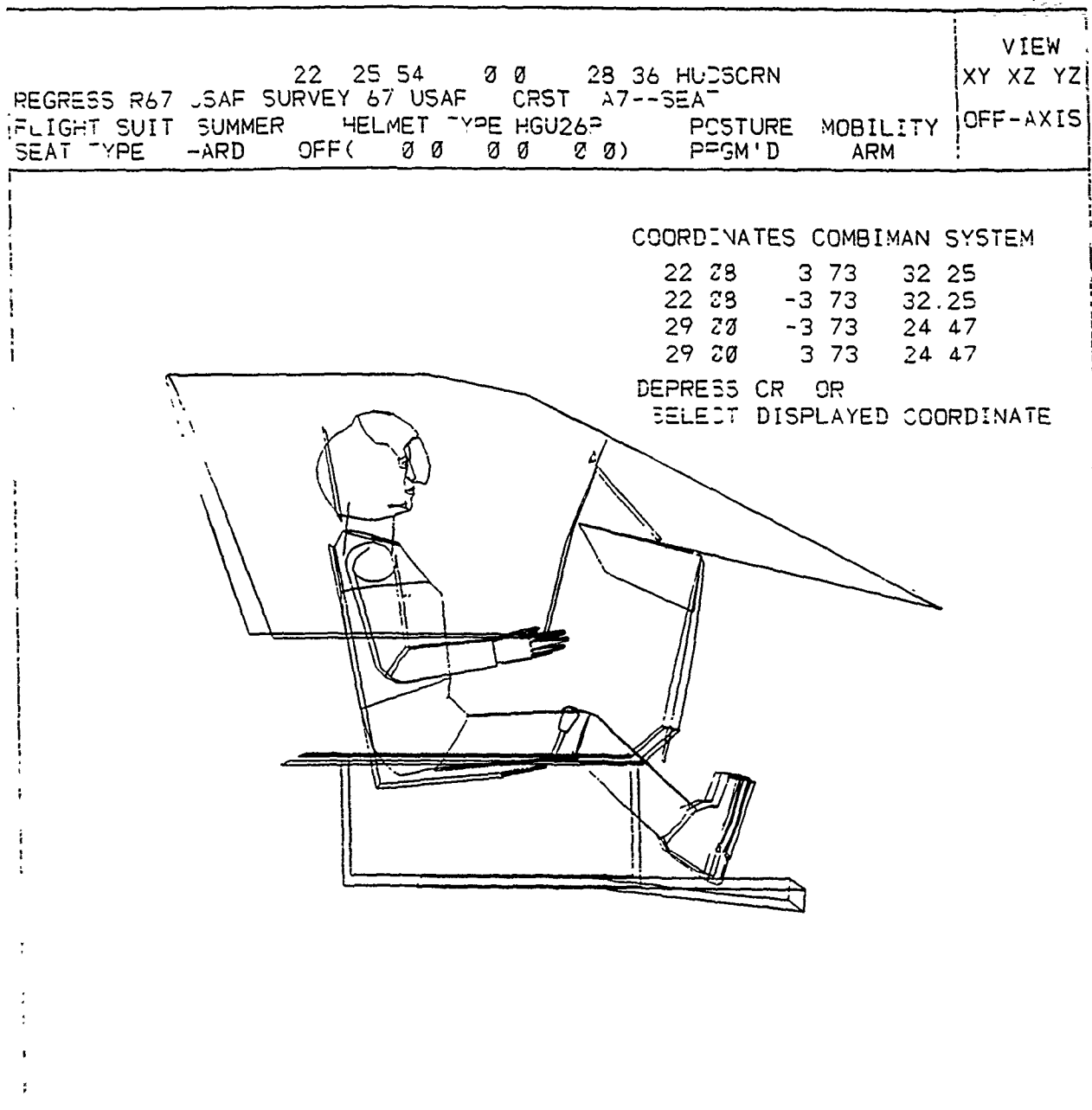


Figure 5.8. Indicator Showing Location of Vertex
for First Set of Coordinates.

5.5 OMIT PANEL FUNCTION (PFK 2)

The Omit Panel function is used to de-clutter the display by temporarily removing one or more panels from the crew station. The data defining the omitted panels are still contained in the permanent Crew Station Data Base, so omitted panels will be redisplayed whenever the crew station is regenerated with the Retrieve Crew Station function (PFK 4). Omitted panels may also be redisplayed with the Include Panel function (PFK 3). The function may be called whenever the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 2 to initiate the Omit Panel function.

RESULT: The next prompt appears (Figure 5.9).

PROMPT: SELECT PANEL TO OMIT BELOW, OR SELECT
OMIT ALL EXIT

ACTION: You may select one or more, all, or none of the panels to be omitted from this display.

- Select a panel from the screen display to omit that specific panel.

OR:

- Select OMIT ALL to omit all panels making up the crew station. This is a useful tool when you wish to work only with a few panels in the crew station. Omitting all panels with this function, and then redisplaying only those panels you wish to work with, using the Include Panel function (PFK 3), is much simpler than omitting all the excess panels individually.

OR:

- Select EXIT to end the function without omitting any panels, or to end the function after more than one panel was selected for omission.

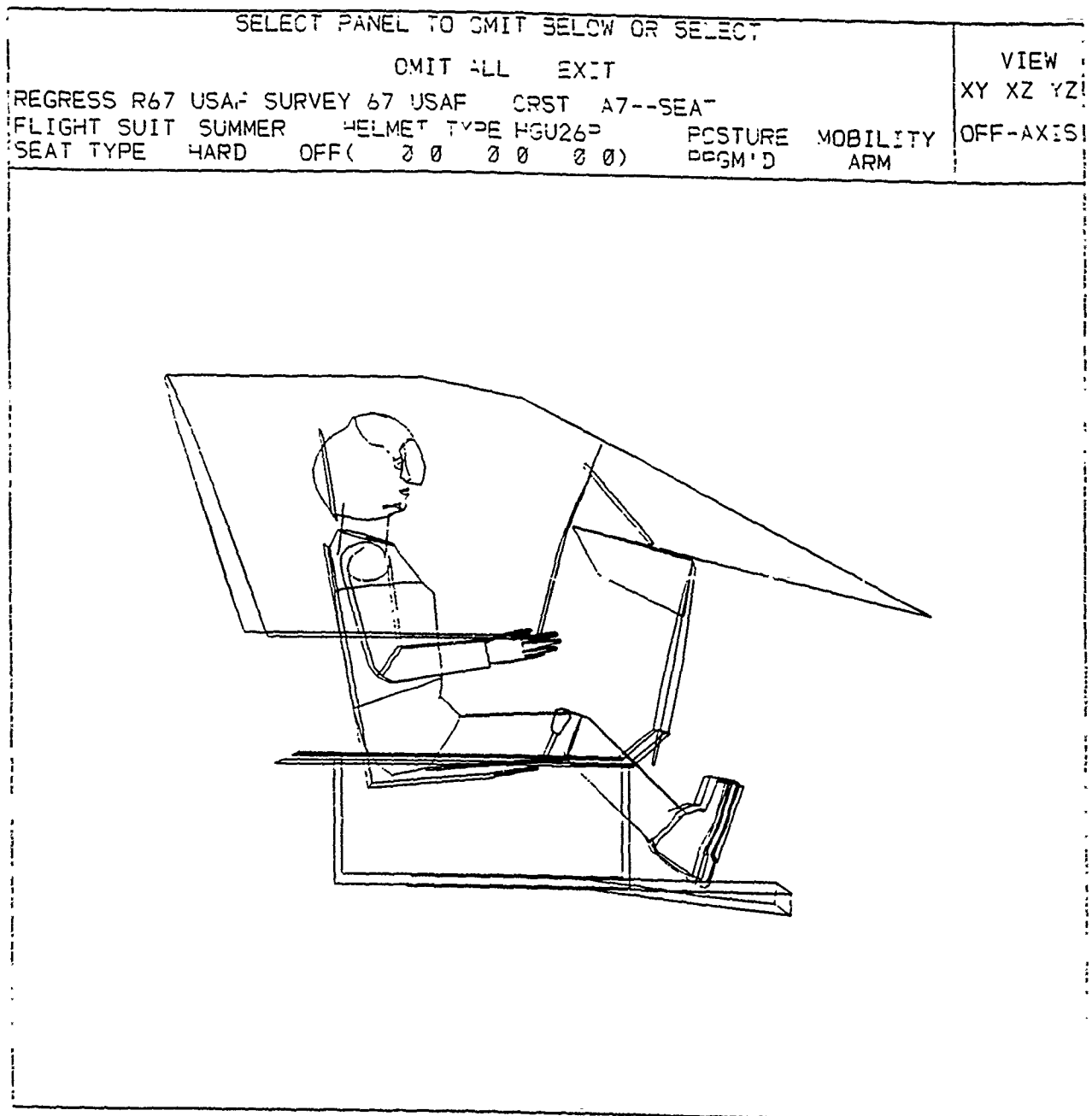


Figure S.9. SELECT PANEL TO OMIT.

EXAMPLE: Select the **Heads Up Display panel** (1 in Figure 5.6) in the screen display area.

RESULT: The selected panel is removed from the display (Figure 5.10). The prompt remains the same. Another panel may be selected for omission from the display as long as this prompt is displayed, until EXIT is selected. When EXIT is selected the function ends.

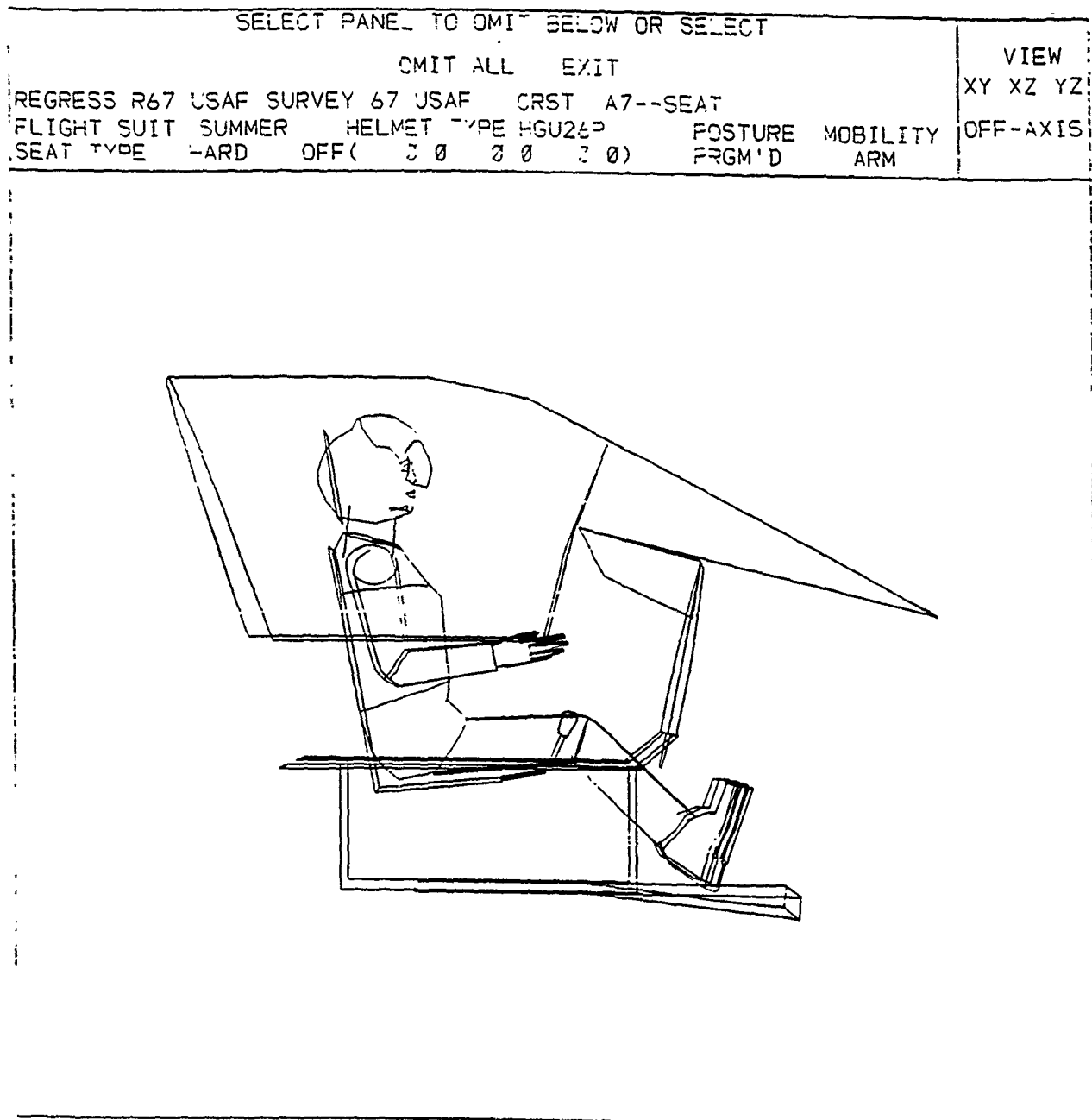


Figure 5.10. Display After the Heads Up Display Panel Was Selected for Omission.

5.6 INCLUDE PANEL FUNCTION (PFK 3)

The Include Panel function is used to redisplay any, or all, panels temporarily removed from the display with the Omit Panel function (PFK 2). The function may be called when the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 3 to start the Include Panel function.

RESULT: Any panel(s) previously omitted are displayed on the screen. The next prompt appears (Figure 5.11).

PROMPT: SELECT PANEL TO INCLUDE BELOW, OR SELECT
INCLUDE ALL PANELS EXIT

ACTION: You may include any one, some, all, or none of the panels previously omitted with the Omit Panel function (PFK 2), by selecting:

- Any one of the individual panels displayed on the screen.

OR:

- INCLUDE ALL PANELS to include all the panels displayed on the screen.

OR:

- EXIT to include none of the panels displayed.

EXAMPLE: Select the Heads Up Display panel (reference 1, Figure 5.6).

RESULT: The crew station is displayed with the Heads Up Display panel included and the function ends. If more than one panel had been previously omitted, the panel selected for inclusion is removed from the display, but the other omitted panels are still displayed. More panels may be selected for inclusion until all desired have been selected and EXIT is selected, at which point the function ends. An INCLUDE ALL PANELS selection changes the screen to display the complete crew station and the function ends.

SELECT PANEL TO INCLUDE BELOW OR SELECT									
INCLUDE ALL PANELS EXIT								VIEW	
								XY	XZ YZ
REGRESS R67	USAF SURVEY 67	USAF	CRST	A7--SEAT					
FLIGHT SUIT	SUMMER	HELMET TYPE	HGU26P	PCSTURE	MOBILITY	OFF-AXIS			
SEAT TYPE	HARD	OFF(	0 0	0 0	0 0)	PRGM'D	ARM		

Figure 5.11. SELECT PANEL TO INCLUDE

SECTION 6

PRINTER-PLOTTER RELATED FUNCTIONS

Printer-Plotter Related functions provide the capability to record hard copy plots of the on-screen display and printed output of the three-dimensional coordinates of the man-model and the crew station.

6.1 OFF-LINE PLOT FUNCTION (PFK 7)

The Off-Line Plot function saves the coordinate data of the man-model and crew station displayed at the end of a function for later use to generate an off-line plot. This function is used with the CBM08NOPL program, and is for those users who do not have an on-line plot capability. The function can be called whenever the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 7 to initiate the Off-Line Plot COMBIMAN function.

RESULT: The next prompt appears.

PROMPT: SELECT TYPE OF PLOT DESIRED
PERSPECTIVE NON PERSPECTIVE

ACTION:

- Select PERSPECTIVE for a plot showing the man-model and crew station with infinite perspective. In a perspective plot, objects displayed farther from the view appear smaller.

OR:

- Select NON PERSPECTIVE for a plot in which objects are the same size regardless of the distance from the viewer.

EXAMPLE: Select PERSPECTIVE.

RESULT: The next prompt appears. The prompt is the same for PERSPECTIVE or NON PERSPECTIVE selection (Figure 6.1).

PROMPT: ENTER PLOT SCALE FACTOR

ACTION: The scale factor is entered by typing the value on the ANKB, followed by <CR>. For a perspective plot, a scale factor of 1.0 produces a 10- x 10- inch plot identical to the size of the Display Area on the CRT. For a non-perspective plot, the scale factor is applied to full-scale data. The user must consider the size restrictions of the available plotter when specifying the scale factor. For example, a 1.0 scale perspective plot is about the same size as a 0.10 scale for a non-perspective plot. A valid scale factor (> 0.0) is required.

EXAMPLE: Enter 1.0, followed by <CR>

RESULT: The next prompt appears (Figure 6.2).

PROMPT: ENTER COMMENTS FOR PLOT

ACTION: Up to 10 lines of comments, with a maximum of 60 characters per line, may be entered. Enter each line from the ANKB, followed by <CR>. To terminate comments, enter <CR> after the last line of comments is entered. The comments appear at the bottom of the screen display area and are printed out on the hard copy plot.

OR:

- If no comments are required, depress <CR> to enter a blank line, followed by another <CR>.

EXAMPLE: Depress <CR>, <CR>

RESULTS: The message "PLOTTING" appears in the prompt area and the data are written to a disk file for later use in making an off-line plot (Figure 6.3). The function terminates.

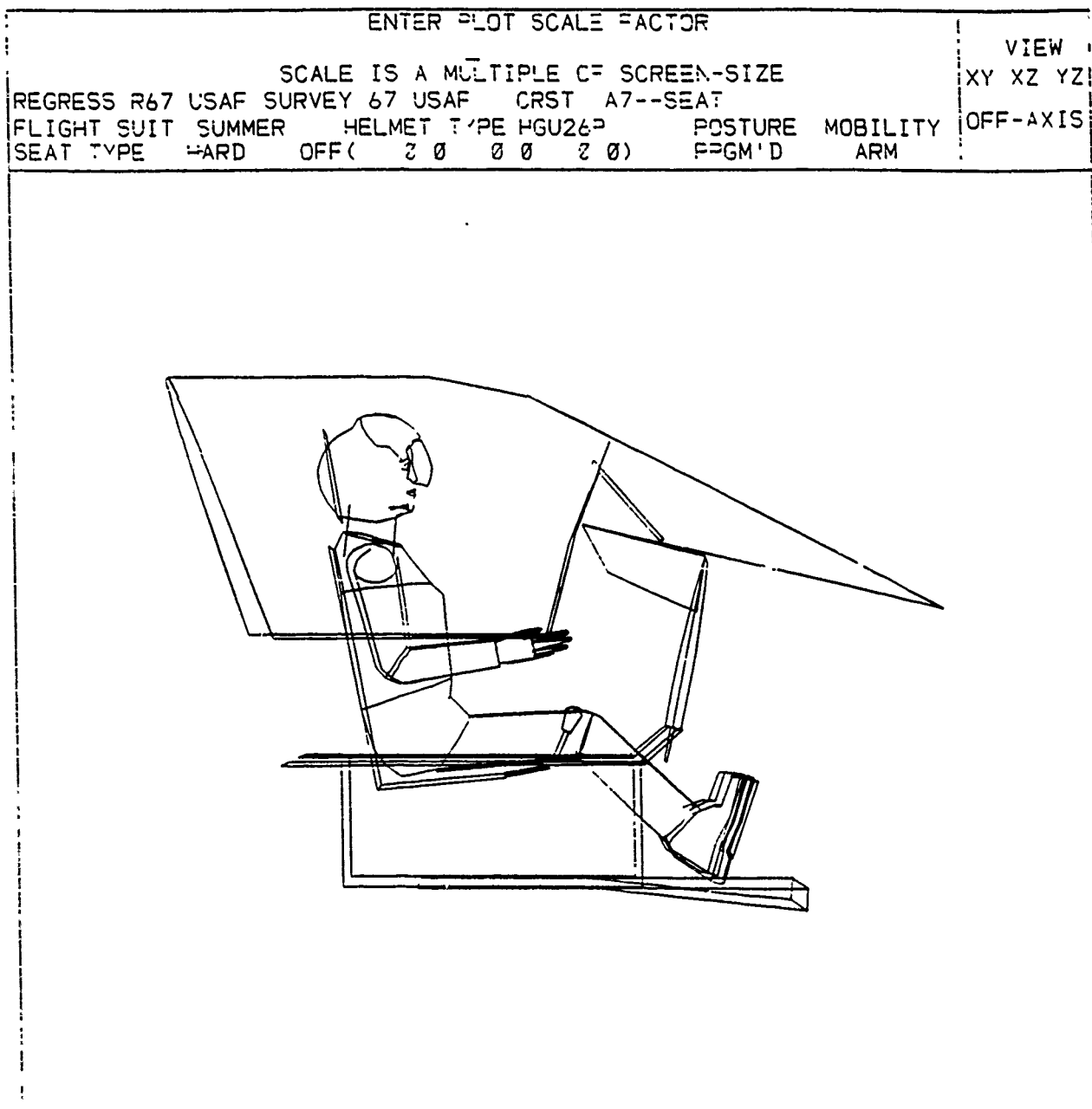


Figure 6.1 Plot Scale Factor.

ENTER COMMENTS FOR PLOT

REGRESS DAT USAF SURVEY 67 USAF IPST 17--5547
 FLIGHT 3.11 SUMMER HELMET TYPE -GJ22B ERSURE MOBILITY OFF-1/15
 HELM TYPE -4PD OFF. 3 0 3 7 3 8 ERSURE 15M

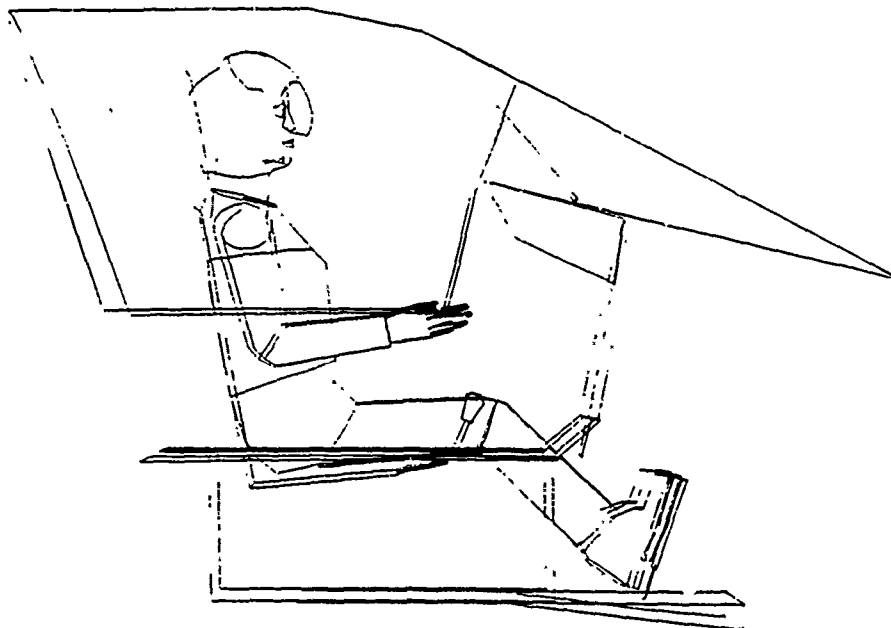


Figure 6.2. Enter Comments for Plot.

DEPRESS PFK TO SELECT A FUNCTION												VIEW					
															XY	XZ	YZ
REGRESS R67 USAF SURVEY 67 USAF CRST A7--SEAT															OFF-AXIS		
FLIGHT SUIT SUMMER HELMET TYPE HGU26P POSTURE MOBILITY																	
SEAT TYPE HARD OFF(0 0 0 0 2 0) PPGM'D ARM																	

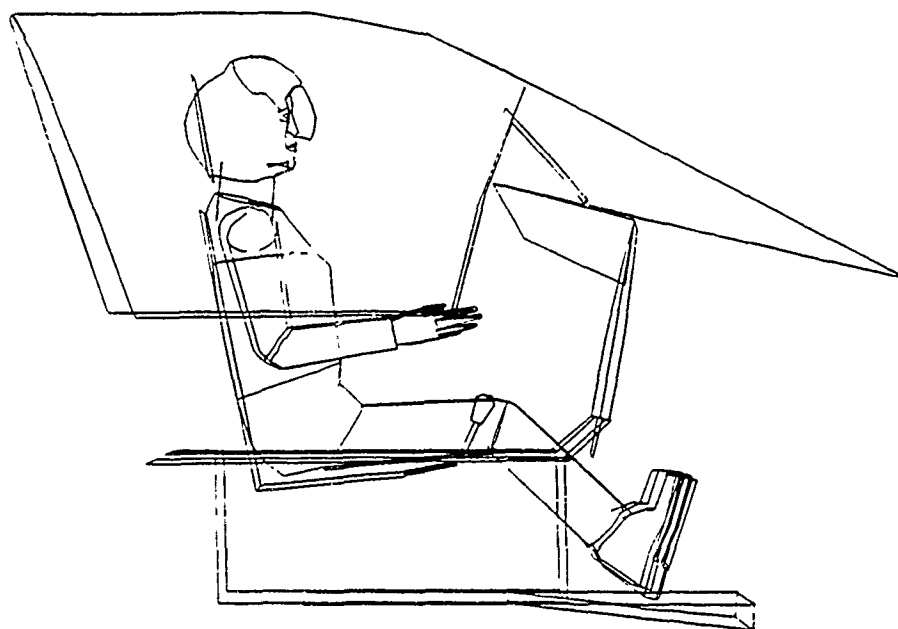


Figure 6.3. Plotting display.

6.2 ON-LINE PLOT FUNCTION (PFK 8)

The On-Line Plot COMBIMAN function generates immediate on-line plots of the man-model and crew station configuration shown in the Display Area of the screen at the termination of a function. It is for those users with an on-line capability and uses the CBM08 program. Otherwise, this function is identical to the Off-Line Plot COMBIMAN function, and can be called whenever the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 8 to initiate the On-Line Plot function.

RESULT: The next prompt appears in the prompting area.

PROMPT: SELECT TYPE OF PLOT DESIRED
PERSPECTIVE NCN PERSPECTIVE

ACTION:

Select PERSPECTIVE for a plot showing the man-model and crew station with infinite perspective. In a perspective plot, objects displayed farther from the view appear smaller.

OR:

- Select NON PERSPECTIVE for a plot in which objects are the same size regardless of the distance from the viewer.

EXAMPLE: Select PERSPECTIVE.

RESULT: The next prompt appears. The prompt is the same for PERSPECTIVE or NON PERSPECTIVE selection (see Figure 6.1).

PROMPT: ENTER PLOT SCALE FACTOR

ACTION: The scale factor is entered by typing the value on the ANKB, followed by <CR>. For a perspective plot, a scale factor of 1.0 produces a 10- x 10-inch plot identical to the size of the Display

Area on the CRT. For a non-perspective plot, the scale factor is applied to full-scale data. The user must consider the size restrictions of the available plotter when specifying the scale factor. For example, a 1.0 scale perspective plot is about the same size as a 0.10 scale for a non-perspective plot. A valid scale factor (> 0.0) is required.

EXAMPLE: Enter 1.0, followed by <CR>.

RESULT: The next prompt appears (see Figure 6.2).

PROMPT: ENTER COMMENTS FOR PLOT

ACTION: Up to 10 lines of comments, with a maximum of 60 characters per line, may be entered. Enter each line from the ANKB, and follow with <CR>. To terminate comments, enter <CR> after the line of comments is entered. The comments appear at the bottom of the screen display area and are printed out on the hard copy plot.

OR:

- If no comments are required, depress <CR> to enter a blank line, followed by another <CR>.

EXAMPLE: Depress <CR>, <CR>

RESULTS: The message "PLOTTING" appears in the prompt area, the plot is made on the on-line plotter, and the function terminates (see Figure 6.3).

6.3 PRINT DATA FUNCTION (PFK 9)

The Print Data function saves the data pertinent to the displayed image at the time the function is called. These data are accumulated and printed at the end of the session. This gives the user a way to record, for future reference, the different configurations during the interactive session. The function may be called whenever the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress **PFK 9** to initiate the Print Data function.

RESULT: The data are accumulated and printed at the end of the session. The Print Data function prints man-model and crew station data. The man-model data consist of, for each link, the X, Y and Z coordinates of the distal end of each link, the transformation angles for each link, and the enfleshment semi-axes lengths. An example of the man-model data output is shown in Figure 6.4. Data for the displayed crew station consist of the name, type, and X, Y, and Z coordinates of all the panel vertices. The coordinates of each control on the displayed crew station together with its name and name of the panel on which it is located, if any, are also printed. Figure 6.5 shows an example of the data output for a crew station.

COMBIMAN LINK DATA

SURVEY DATA OF 67 USAF

NO.	NAME	-----DISTAL END-----			-----JOINT ANGLES-----			-SEMI AXIS LENGTHS-		
		X	Y	Z	PHI	THETA	PSI	ALPHA	BETA	GAMMA
0	SNP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	SNP-MIIP	4.64	0.0	3.41	0.0	53.70	0.0	4.53	7.41	4.58
2	MIIP-L34	2.82	0.0	8.26	0.0	-74.20	0.0	4.37	6.07	4.37
3	CHIESI	0.22	0.0	17.37	0.0	4.80	0.0	4.81	6.43	4.81
4	189-11	-0.48	0.0	24.82	0.0	10.00	0.0	3.61	8.01	3.61
5	AECK	0.80	0.0	29.87	0.0	20.00	0.0	0.0	0.0	0.0
6	NECK-MHD	0.80	0.0	31.28	0.0	-14.30	0.0	3.83	3.04	4.47
7	MHD-MEVE	4.14	0.0	31.28	0.0	90.00	0.0	0.0	0.0	0.0
8	MEVE-MEY	4.14	-1.25	31.28	-90.00	90.00	0.0	0.0	0.0	0.0
9	MEVE-LEY	4.14	1.25	31.28	90.00	90.00	0.0	0.0	0.0	0.0
10	11-MSS	2.56	0.0	23.76	0.0	115.00	0.0	0.0	0.0	0.0
11	MSS-MSS	2.56	-1.00	23.76	-90.00	90.00	29.30	0.0	0.0	0.0
12	MSS-RSLD	-1.14	-8.01	21.44	22.00	31.90	0.0	0.0	0.0	0.0
13	RSLD	-1.14	-8.01	21.44	0.0	-31.90	-112.00	2.31	2.30	2.07
14	RUPARM	0.76	-8.01	10.68	0.0	-90.00	-90.00	1.73	1.73	1.73
15	RLWARM	11.16	-8.01	12.51	0.0	90.00	0.0	1.10	1.10	1.10
16	RGRIP	13.13	-8.01	12.86	0.0	0.0	0.0	2.01	0.54	3.76
17	RFNHCH	15.71	-8.01	13.33	0.0	0.0	0.0	0.0	0.0	0.0
18	RFNHCHIP	18.57	-8.01	13.82	0.0	0.0	0.0	0.0	0.0	0.0
19	MSS-LSS	2.56	1.00	23.76	90.00	90.00	-29.30	0.0	0.0	0.0
20	LSS-LSLD	-1.14	0.01	21.44	-22.00	31.90	0.0	0.0	0.0	0.0
21	LSLD	-1.14	8.01	21.44	0.0	-31.90	112.00	2.31	2.30	2.07
22	LUPARM	0.76	8.01	10.68	0.0	-90.00	90.00	1.73	1.73	1.73
23	LLWARM	11.16	8.01	12.51	0.0	90.00	0.0	1.10	1.10	1.10
24	LGRIP	13.13	8.01	12.86	0.0	0.0	0.0	2.01	0.54	3.76
25	LFNRLH	15.71	8.01	13.33	0.0	0.0	0.0	0.0	0.0	0.0
26	LFNCHTIP	18.57	8.01	13.82	0.0	0.0	0.0	0.0	0.0	0.0
27	MIIP-MIIP	4.64	-3.43	3.41	-90.00	90.00	53.70	3.24	3.24	4.10
28	RUPMLEG	21.53	-3.43	5.48	97.00	90.00	-90.00	2.15	2.16	2.16
29	RLWMLEG	31.25	-3.43	-7.42	0.0	60.00	0.0	1.40	1.40	1.40
30	RANKLL	32.56	-3.43	-9.18	0.0	0.0	0.0	5.32	1.92	1.28
31	MIIP-LIIP	4.64	3.43	3.41	90.00	90.00	-53.70	3.24	3.24	4.10
32	LUPMLEG	21.53	3.43	5.48	-97.00	90.00	90.00	2.15	2.16	2.16
33	LLWMLEG	31.25	3.43	-7.42	0.0	60.00	0.0	1.40	1.40	1.40
34	LANKLL	32.56	3.43	-9.18	0.0	0.0	0.0	5.32	1.92	1.28

Figure 6.4. Sample Man-model Output
for COMBIMAN Print Data Function.

COMBIMAN CREW STATION PANEL DATA

CREW STATION DATA OF A7E-01

<u>NO.</u>	<u>PANEL NAME</u>	<u>TYPE</u>	
1	LMIPAN	1	(29.75, 0.0 , 5.94) (29.75, 14.75, 5.94) (31.34, 14.75, 13.39) (32.59, 9.57, 19.30) (33.20, 4.50, 22.14) (33.20, 0.0 , 23.00)
2	RMIPAN	1	(29.75, 0.0 , 5.94) (29.75, -14.75, 5.94) (31.34, -14.75, 13.39) (32.59, - 9.57, 19.30) (33.20, - 4.50, 22.14) (33.20, 0.0 , 23.00)
3	FWDLHCON	1	(26.23, 9.25, 2.89) (26.23, 18.75, 2.89) (28.31, 18.01, 4.68) (29.79, 17.18, 5.93) (29.79, 9.29, 5.93)
4	LHCON	1	(26.09, 9.25, 2.76) (- 8.40, 9.25, 2.76) (- 8.40, 23.01, 2.76) (26.09, 20.00, 2.75)
5	AFTLHCON	1	(- 3.35, 8.50, 2.76) (- 8.53, 8.50, 2.76) (- 8.53, 23.52, 2.76) (- 3.40, 23.00, 2.75)
6	FWDRHCON	1	(26.23, - 9.25, 2.89) (26.23, -18.75, 2.89) (28.31, -18.01, 4.68) (29.79, -17.18, 5.93) (29.79, - 9.28, 5.93)
7	RHCON	1	(26.09, - 9.25, 2.76) (- 8.40, - 9.25, 2.76) (- 8.40, -23.53, 2.76) (26.09, -20.00, 2.75)

Figure 6.5. Partial Crew Station Data Printout as an Example of the Format.

SECTION 7

TASK RELATED ANALYSIS FUNCTIONS

The Task Related Analysis functions are the most important functions of COMBIMAN, and are used to assess the interactions of a human operator in the crew station environment. The other categories of functions are used to prepare the system for assessing man-machine interactions, and for providing printouts and plots of the information which was used, or developed, in making such assessments. Once the user has defined the task, the COMBIMAN software uses expert system techniques to execute the task and display the results. Four types of analyses can be performed; fit, reach capability with the arms and legs, strength capability for operating controls, and visual fields.

Fit is accomplished by placing the appropriately sized man-model in the crew station and analyzing the clearance between the man-model and crew station structure. This analysis is done by visual inspection or measurement of scaled plots. For example, if there was a need to check the clearance of the ejection envelope for varying body sizes and seat positions, the man-model, in the required sizes, would be placed in the crew station, the seat adjust function used to vary the seat position, and plots of the various combinations made. Properly scaled ejection envelope limits could be overlaid on the plots and checks made for the required clearance.

Reach analysis can be performed with the arms, or legs, and is a function of body size (arm and leg length), seat adjustment

(relative location of the body to the reach point), joint mobility range (including the encumbrance of clothing and personal protective equipment), and grip type. Crew stations have four general types of controls; three requiring hand grips and the other being foot operated pedals.

COMBIMAN has three hand grip types:

Grip center (whole-hand grip) for use in operating controls such as levers and flight control sticks and wheels.

Functional reach for operating controls such as rotary knobs and switches.

Fingertip reach for such controls as push buttons and toggle switches.

Two types of reach analysis are available in COMBIMAN. First, a reach to a single control, or a point in space. Once the control, or point in space, is designated the COMBIMAN simulates and displays a reach toward that point. The movements are automatically limited by the joint mobility range limits, as encumbered by the clothing selected, and by the lap belt and shoulder harness restraints. Second, a reach envelope in the plane of a specified panel, such as an instrument, or avionics control, panel. The encumbered joint mobility range limits and lap belt and shoulder harness restraints are also considered in computing the reach envelope to a specified panel. The man-model is not shown reaching toward the panel, but the intersection of the reach envelope and the panel is displayed. Printouts providing body dimensions, joint angles, and coordinates of the work station are generated. Scaled plots of the display can also be made.

Analysis of strength capabilities (force that can be applied) is based on the premise that the point of force application can be reached. Data from years of strength research have been modeled to provide accurate computations of available strength for operating controls. Available strength is computed by COMBIMAN for the 1st, 5th, 50th, 95th and 99th percentiles of the strength population, for Air Force male and female pilots, as a function of control location, direction of force and control type. In general, if a point or control in the forward hemisphere from the man-model can be reached, the available strength can be computed. There are some extreme points which can be reached which are beyond the range of the strength data. Printouts providing body dimensions, joint angles, and coordinates of the crew station are generated. Plots of the screen display can also be made in variable scale.

The analysis of visual field plots the crew station as seen by the COMBIMAN. The limits of peripheral vision, field of resolution, and helmet/mask assemblies are superimposed on the crew station display. COMBIMAN allows a range of head and eye positions, as occurs with a human pilot. The size of the operator, seat adjustment, head position and visual restrictions may be readily varied for realistic evaluation of the pilot's vision field. The overlays are projected from the mid-eye position of the man-model. On screen presentations and hard copy plots are available. The hard copy plots may be scaled to meet the scale requirements, 0.1 inch equals 1 degree of azimuth and elevation, established by MIL-STD-850 (Aircrew Station Vision Requirements

for Military Aircraft).

7.1 PERFORM REACH ANALYSIS FUNCTION (PFK 11)

The Perform Reach Analysis function of the COMBIMAN allows evaluation of the aircrew member's ability to reach and operate controls. This ability is a function of body size and clothing type (selected with the Define Body Size function PFK 4), mobility limits (seat harness and lap belt restraints) and the location and type of control. The user specifies the location of the point which the man-model attempts to reach. The mobility limits and clothing type selected cause the man-model to reach toward the designated reach point with realistic joint mobility.

Two handed reaches may be made to the same, or different, points. When performing reaches, the right hand always reaches first. The left hand makes the second reach and is only with limited mobility, as the posture is frozen after the right hand reach.

The extent of reach type corresponds to the three types of grips available in COMBIMAN; Grip Center reach for activating handles and levers, Functional reach for operating rotary knobs, and Finger Tip reach for operating push buttons. The leg reach is for reaching foot (rudder) pedals. Before using the Perform Reach Analysis function, the anthropometry and clothing type used in defining the COMBIMAN should be considered. If arm reach to hand operated controls is to be analyzed, the ARM LENGTH variable under Option 2 of the Define Body Size function (PFK 4) should be used as the length related variable in defining the body size.

If a leg reach is to be analyzed, the LEG LENGTH variable should be used. In making analyses, the displacement of the control should be considered. For controls having a large, or multi-axis, displacement, the reach ability to maximum displacements may be a necessary consideration. The varying body sizes of the populations being analyzed may also be a valid consideration at the various control locations. The function may be called at any time the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 11 to call the Perform Reach Analysis function.

RESULT: Next prompt appears in prompting area (Figure 7.1).

PROMPT: SELECT MOBILITY
ARM LAP BELT SHOULDER

ACTION: Select the desired mobility limit from the three choices. The selection determines the amount of joint mobility allowed in reaching to the reach point. Once the mobility is selected it cannot be changed without exiting, and then recalling, the function.

- Select ARM - Allows arm movement only with the shoulder and torso fixed.

OR:

- Select LAP BELT - Allows arm, shoulder and torso movement as with a lap belt only.

OR:

- Select SHOULDER - Allows arm and shoulder movement with the torso fixed, as with a locked shoulder harness.

EXAMPLE: Select SHOULDER

RESULT: The mobility selected is displayed in the right of the prompting area (Figure 7.2).

SELECT MOBILITY										VIEW		
										XY	XZ	YZ
REACH ANALYSIS	ARM	LAP BELT	SHOULDER									
REGRESS R67 USAF SURVEY 67 USAF	CRST	A7--SEAT										
FLIGHT SUIT SUMMER	HELMET TYPE FG026P	POSTURE	MOBILITY	OFF-AXIS								
SEAT TYPE -ARD	OFF(0 0 0 0 0 0)	SLUMPED	ARM									

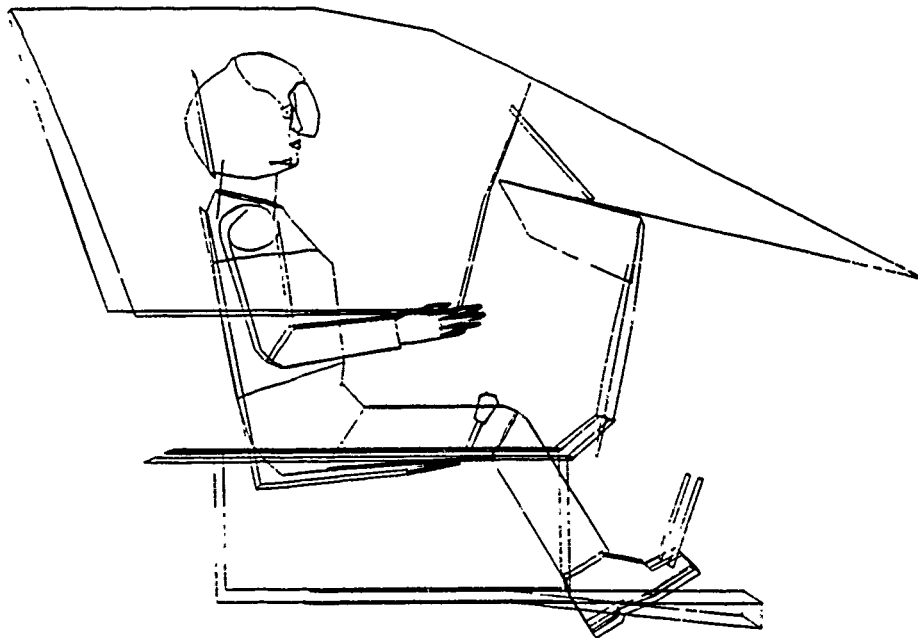


Figure 7.1 PERFORM REACH ANALYSIS Function. Select Reach Mobility

SELECT REACH TYPE										VIEW		
										XY	XZ	YZ
REACH ANALYSIS		BOTH		RARM		LARM		PLEG		LLEG		
REGRESS R67		USAF SURVEY 67		USAF		CRST		A7--SEAT				
FLIGHT SUIT		SUMMER		HELMET		TYPE		AGU263		POSTURE		MOBILITY
SEAT TYPE		HARD		OFF		2 0		0 0		0 0		OFF-AXIS
										SLUMPED		S-SHOULDER

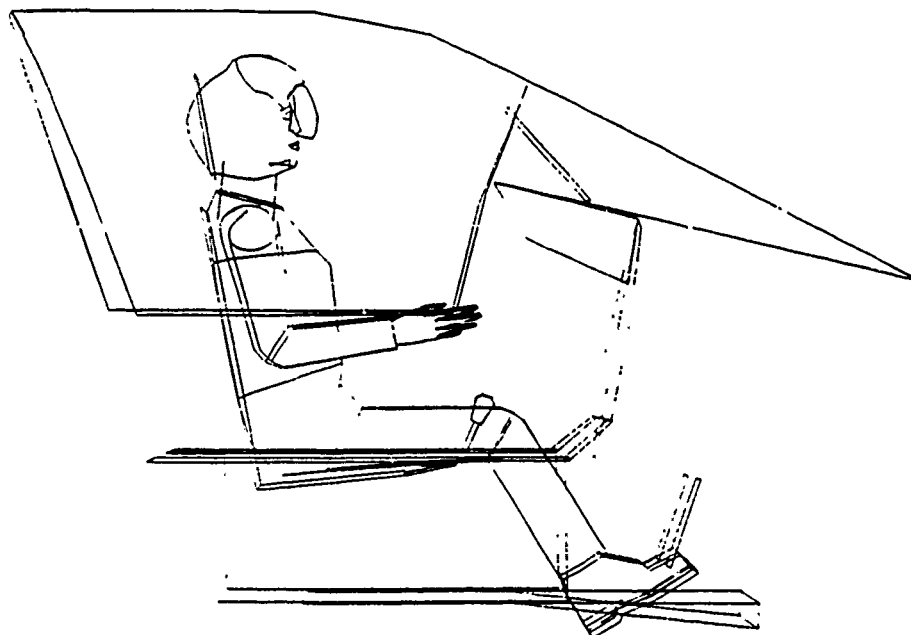


Figure 7.2 PERFORM REACH ANALYSIS Function. Select Reach Type.

PROMPT: SELECT REACH TYPE
 BOTH RARM LARM RLEG LLEG

ACTION: Select the desired limb(s) to reach to the point later designated as the reach point. To select either leg reach a crew station must be present on the screen.

- Select BOTH for a reach to the same, or a different, point by both arms.

OR:

- Select RARM (right arm) or LARM (left arm) for a single arm reach.

OR:

- Select RLEG (right leg) or LLEG (left leg) reach to a rudder pedal.

OR:

- Depress <CR> to exit function.

The result depends on whether a single arm or both arm or leg reach is selected. For ease of following paragraph 7.1.1 will cover the procedures for a single arm reach. Paragraph 7.1.2 covers the procedures for a two arm reach, and 7.1.3 covers the leg reach.

7.1.1 Single Arm Reaches

EXAMPLE: Select LARM

RESULT: The selected reach type is displayed to the right of the information area and the next prompt appears (Figure 7.3).

PROMPT: SELECT EXTENT OF REACH
 GRIPCTR FNCTRCH FNGRTP

ACTION: The grip type determines the extent of reach from the shoulder to the reach point. From the shoulder to the finger tip (FNGRTP) is a longer distance than from the shoulder to the grip center (GRIPCTR). Figure 7.4 displays the three different grip types. Select the appropriate grip type for the analysis being made.

SELECT EXTENT OF REACH													
REACH ANALYSIS						GRIPCTR		FNCTPCH		FNGRTP		VIEW	
						_ARM				XY XZ YZ			
REGRESS P57 USAF SURVEY 67 USAF						CRST		A7--SEAT					
FLIGHT SUIT SUMMER						HELMET TYPE		-G026P		POSTURE			
SEAT TYPE -ARD						OFF(3 0 3 0 3 0)		SLUMPED		MOBILITY OFF-AXIS SHOULDER			

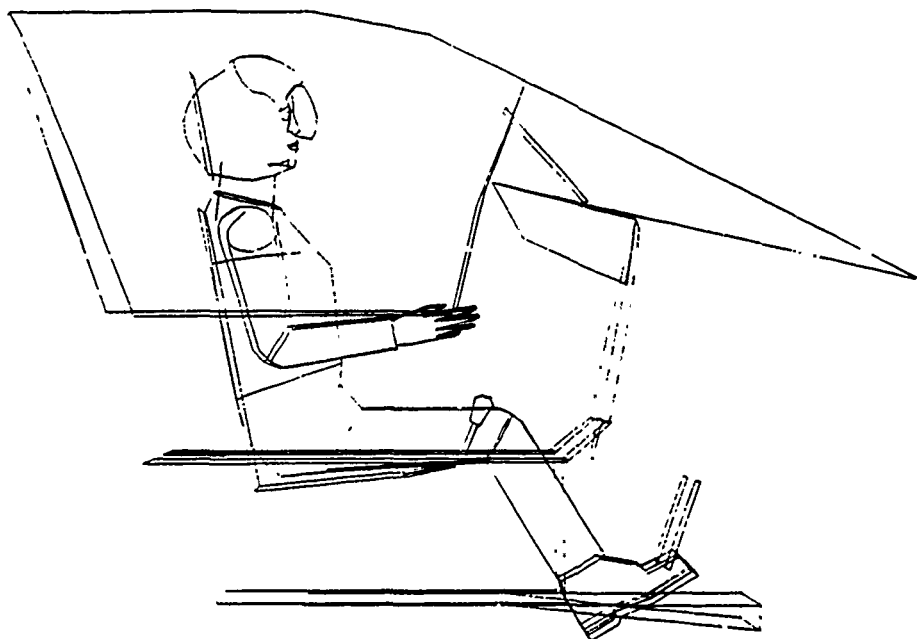
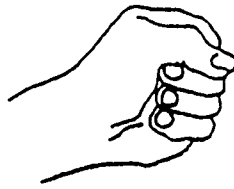
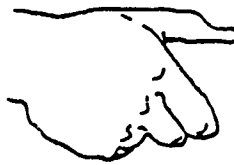


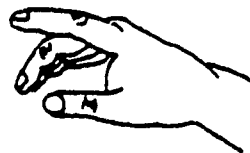
Figure 7.3 PERFORM REACH ANALYSIS Function.
Select Extent of Reach.



GRIP CENTER



FUNCTIONAL REACH



FINGER TIP REACH

Figure 7.4 Relative Location of Grip Points.

- Select GRIPCTR (grip center reach) when the reach is to be made to a handle or lever.

OR:

- Select FNCTRCH (functional reach) when the reach is to be made to a switch, or control, requiring a grasp with the fingers and thumb, for example a rotary knob.

OR:

- Select FNGRTP (fingertip reach) when reaching to a switch, or control, requiring movement by the finger tip.

EXAMPLE: Select FNGRTP, for example, reaching to a push button type control.

RESULT: The man-model and crew station are displayed in the side view (XZ plane) with a movable cursor (+) located at the seat reference point (Figure 7.5). The PFKs are temporarily re-defined for an arm reach. The next prompt appears in the prompting area.

PROMPT: POSITION REACH POINT

ACTION: The arm for which the reach point is being positioned is displayed in the information area (RARM or LARM). Position the cursor to define the X and Z coordinates of the reach point. The movement of the cursor is controlled by depressing the re-defined PFKs. The direction and magnitude of movement are as indicated inside and below the circles representing the re-defined PFK's in figure 7.6. By selecting the proper PFK the cursor moves up, down, right, left, or in combinations of horizontal and vertical movements, at two different speeds. The speed is controlled by PFK 26 (SINGLE STEP ON) and PFK 27 (SINGLE STEP OFF). With SINGLE STEP ON the cursor moves, in the direction and magnitude indicated, each time the PFK is depressed. With SINGLE STEP OFF (condition existing when function is activated) the cursor moves in the direction and magnitude indicated at a speed of approximately 10 steps per second. This rapid movement may be stopped by depressing either PFK 7 (STOP) or PFK 26 (SINGLE STEP ON). As the cursor moves, the values of the coordinates appear in the upper left hand corner of the display area.

REGRESS	PAT	USAF	SURVEY	5	USAF	OPS	ATE-21	ARM	12	12
POSITION	REACH	POINT								
SUMMED	-ELVE	-TYPE	-30000	POSTURE	VERTICAL	OFF-1.17				
HARD	OFF	2 2	2 2	2 2	2 2	2 2	FLUMPED	FLUMPED		

REACH- POINT

2 2 2 2 2 2

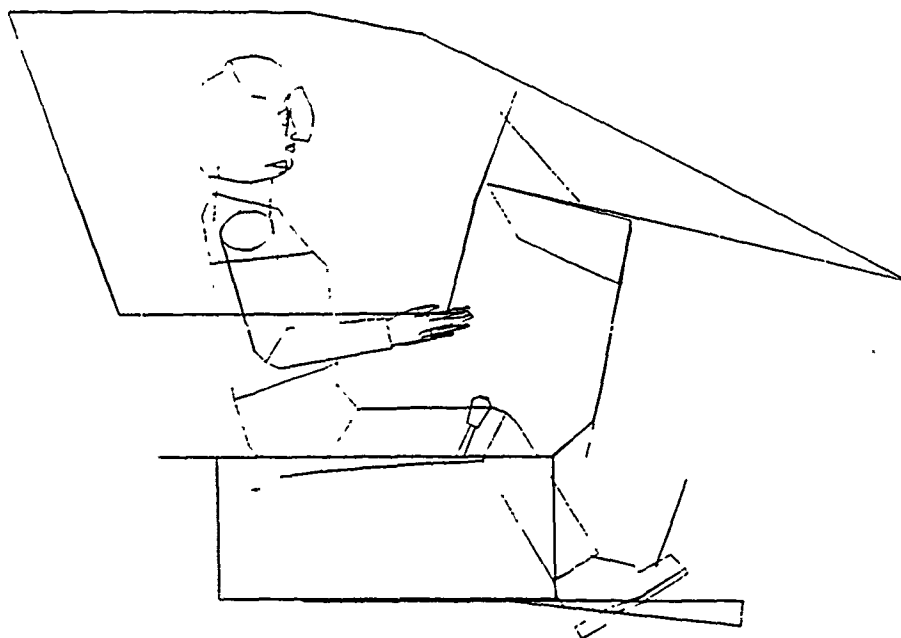


Figure 7.5 Position Reach Point. Side View (XZ Plane) The + Symbol Locates the Reach Point. X and Z coordinates are defined and displayed in the upper left hand display area.

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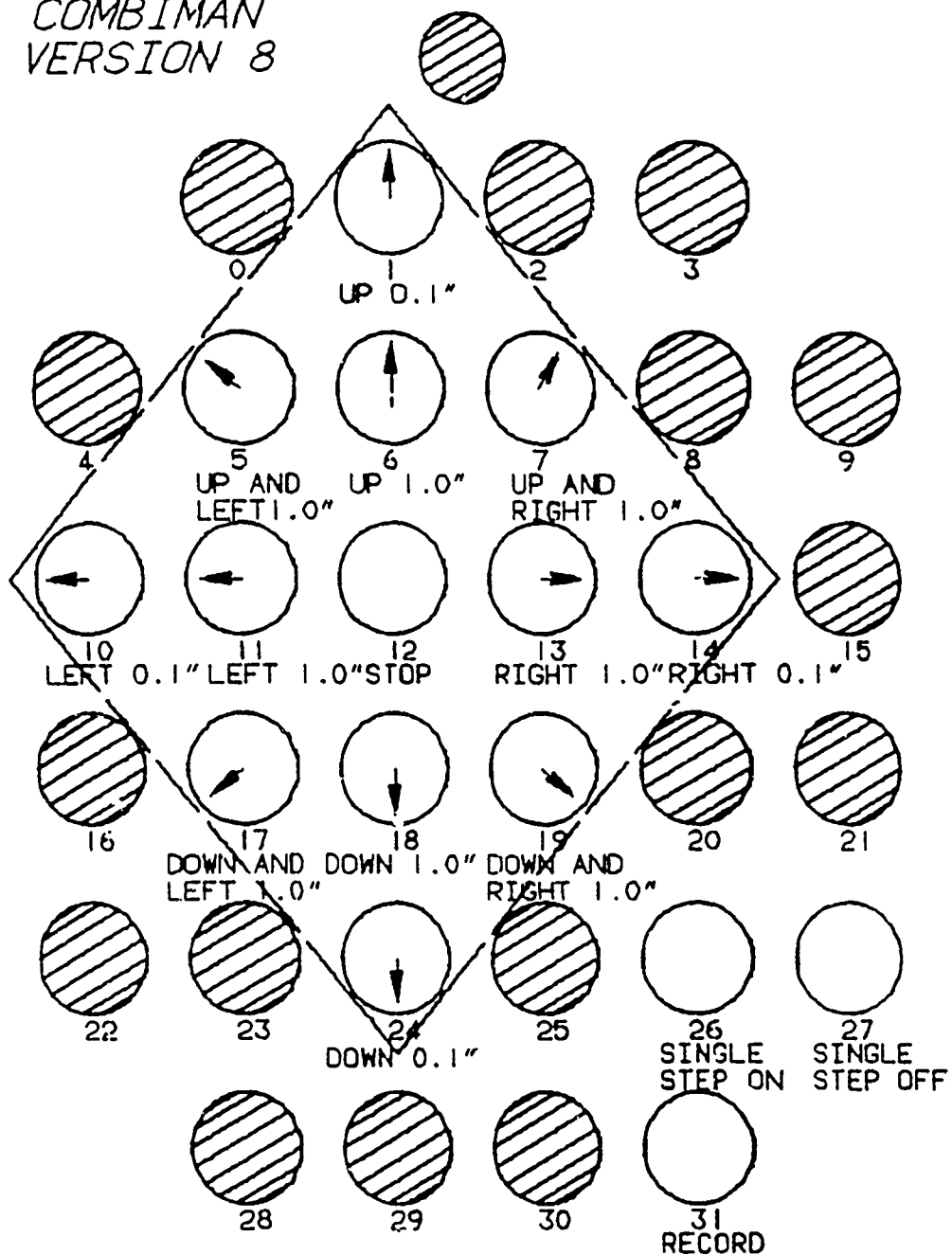


Figure 7.6. Re-defined Program Function Keys for Positioning the Cursor (+). Shaded keys are not used or illuminated.

EXAMPLE: Move cursor right and up until positioned at
X = 24.70 and Z = 27.00, and depress
PFK 31 (RECORD).

RESULT: The man-model and crew station are displayed in a
front view, with the cursor located at the position
corresponding to the X and Z coordinate values.
The prompt remains the same (Figure 7.7).

PROMPT: POSITION REACH POINT

ACTION: Position the cursor to the desired Y coordinate
location by using the left and right direction
PFKs. If an up, down, or multi-directional PFK is
depressed, the Z coordinate value will also
change. The Y, and Z (if cursor is moved up or
down) coordinate values appear in the upper left
of the display area while the cursor is moving.
When the cursor is positioned in the desired
location, depress PFK 31.

EXAMPLE: Move cursor to the left until at the location
Y = 9.00, and depress PFK 31 (RECORD).

RESULT: The PFKs are reset to their original definition
after identifying the reach point. The man-model
looks toward and attempts to reach the specified
point. When the reach to the point is successful,
"REACH SUCCESSFUL" is displayed at the right of
the information area (Figure 7.8). The man-model
is displayed looking toward, and reaching to, the
reach point or pedal. If the man-model cannot
reach the point (the man-model still looks at the
point and is displayed reaching as close to the
point as possible) the message "MISS DISTANCE" and
the miss distance in inches are displayed in the
information area (Figure 7.9). The next prompt
appears in the prompting area.

PROMPT: DO YOU WANT TO RESET POSTURE? SELECT YES OR NO BELOW
YES NO

ACTION: Select one of the two alternatives.

- Select YES to return to the posture (slumped) of
the man-model before the reach was made.

OR:

- Select NO to terminate the function.

EXAMPLE: Select YES

REACH ANALYSIS -		POSITION REACH POINT		VIEW	
REGRESS R67	USAF SURVEY 67	USAF	CRST	A7--SEAT	XY YZ YZ
FLIGHT SUIT	SUMMER	HELMET	TYPE	HGU26P	POSTURE
SEAT TYPE	HARD	OFF	(3 0 0 0 0 0)	BLUMPED	3-SHOULDER

REACH POINT		
X	Y	Z
24 70	0 0	27 00

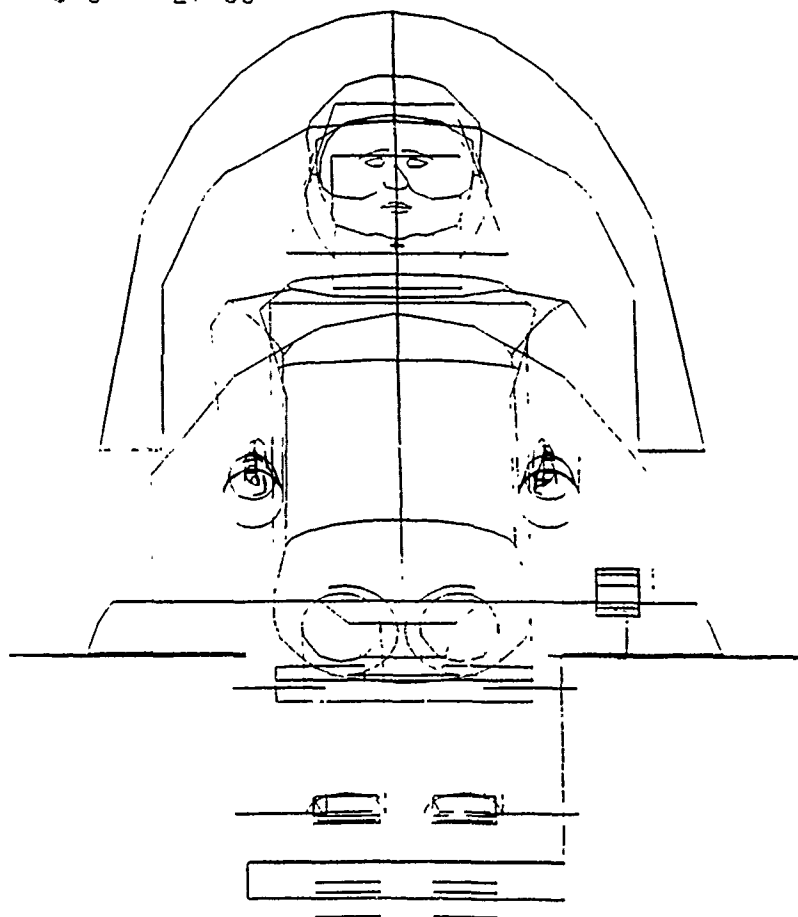


Figure 7.7. Position Reach Point. Front View (YZ Plane). The Cursor (+) Locates the Reach Point. Y and Z coordinates are defined and displayed in the upper left hand of the display area.

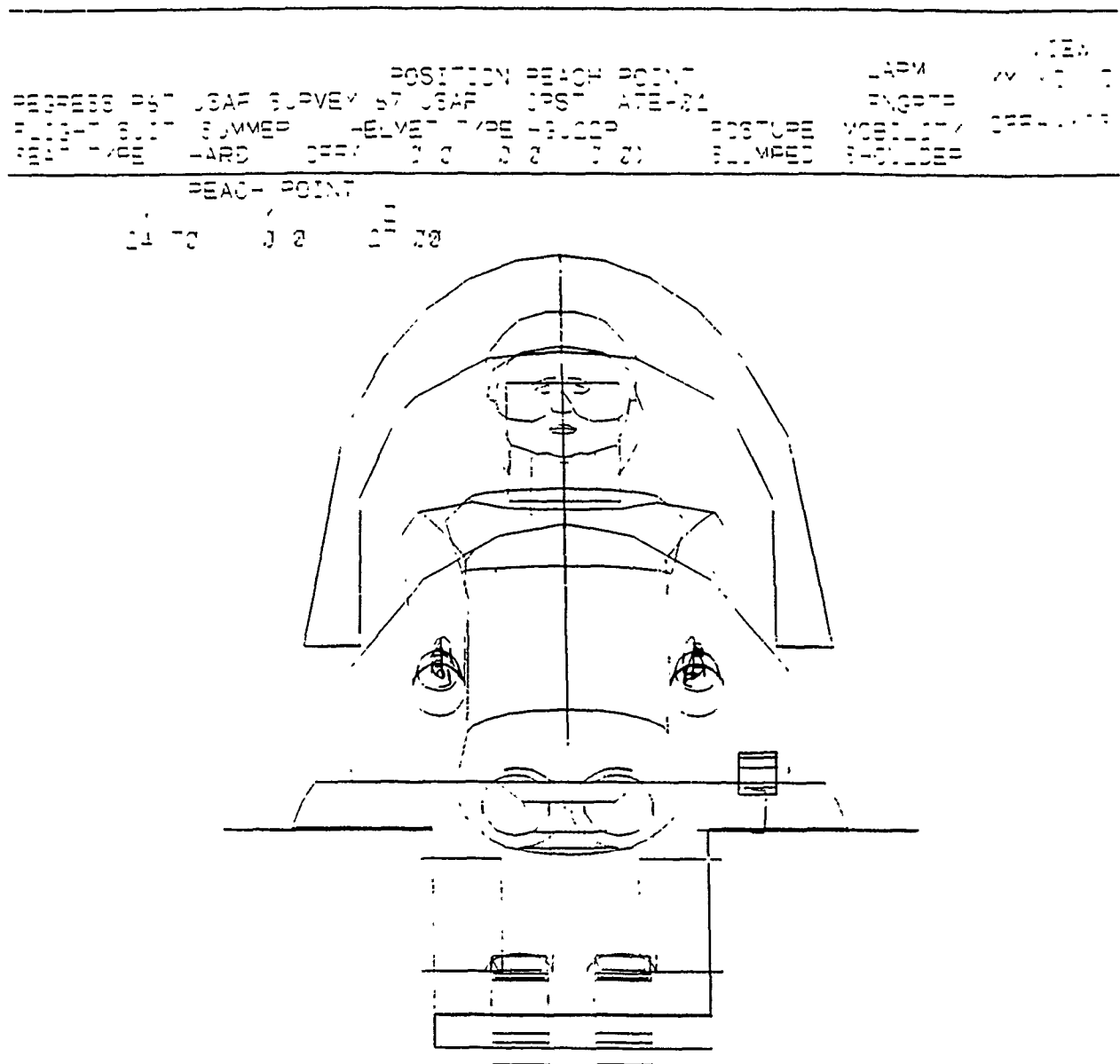


Figure 7.8. REACH SUCCESSFUL is Displayed after a Successful Reach is Performed.

DO YOU WANT TO RESET POSTURE? SELECT YES OR NO BELOW

REACH ANALYSIS		YES	NO	MISS DISTANCE		VIEW		
						XY	YZ	YZ
REGRESS P-7	USAF SURVEY 67	USAF	CRST	47--SEAT	11 12			
FLIGHT SUIT	SUMMER	HELMET	TYPE	HGU26P	POSTURE	MOBILITY	OFF-AXIS	
SEAT TYPE	HARD	OFF	(3 0	0 0	0 0	SLUMPED	E-SHOULDER	

REACH POINT

X	Y	Z
39 00	3 0	34 20

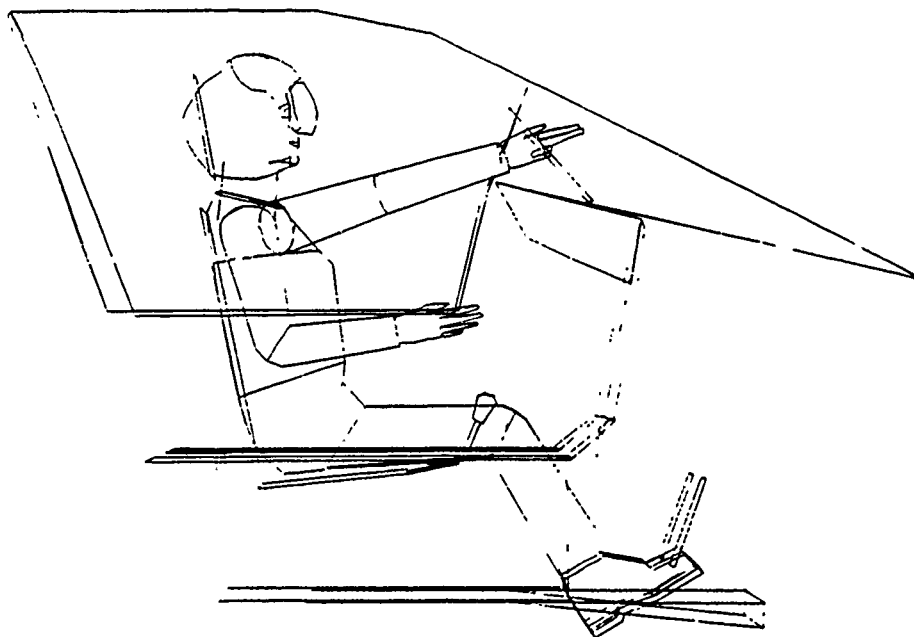


Figure 7.9. MISS DISTANCE is Displayed if the Man-model Could Not Reach the Point.

RESULT: Posture resets to the original (slumped) posture.
The next prompt appears.

PROMPT: DO YOU WANT TO CONTINUE REACH? SELECT YES OR NO BELOW
YES NO

ACTION: Select one of the two alternatives.

- Select YES to continue the reach analysis with the same mobility as previously selected.

OR:

- Select NO to terminate the function.

EXAMPLE: Select YES

RESULT: The program returns to the Select Reach Type and the procedures are repeated until a NO response terminates the function.

7.1.2 Two Arm Reaches

EXAMPLE: Select BOTH for a reach by the right arm, and then the left arm, to the same, or a different, point. In making the reach, the right arm reaches first, the posture attained in the right arm reach is frozen, and the left arm reach is initiated from that posture.

RESULT: The next prompt appears.

PROMPT: SELECT EXTENT OF REACH
GRPCNTR FNCTRCH FNGRTP

ACTION: Select one of the three choices.

- Select GRPCNTR for a reach to a handle or lever type control.

OR:

- Select FNCTRCH to a control requiring a grasp with the finger and thumb, such as to a rotary knob.

OR:

- Select FNGRTP to a finger actuated control, such as a push button or toggle switch.

EXAMPLE: Select GRPCNTR

PROMPT: POSITION REACH POINT

RESULT: The crew station and man-model are displayed in a front view, with the cursor located at the position corresponding to the X and Z coordinate values. The prompt remains the same.

PROMPT: POSITION REACH POINT

RESULT: The PFKs are reset to their original definition. The man-model looks toward, and reaches to, the specified reach point. If the reach is successful the message "REACH SUCCESSFUL" is displayed at the right of the information area. If the reach is unsuccessful, the message "MISS DISTANCE" and the miss distance in inches are displayed at the right of the information area. The next prompt appears in the prompting area.

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PEACH ANALYSIS		POSITION REACH POINT		BOTH RT		VIEW	
REGRESS	R67	USAF SURVEY	67	USAF CRST	A7--SEAT	GRIPCTR	XY XZ YZ
FLIGHT SUIT	SUMMER	HELMET TYPE	-G026P	POSTURE	MOBILITY	OFF-AXIS	
SEAT TYPE	HARD	OFF(	0 0 0 0 0 0)	SLOMPED	S-COLDER		

REACH POINT		
X	Y	Z
0 0	0 0	0 0

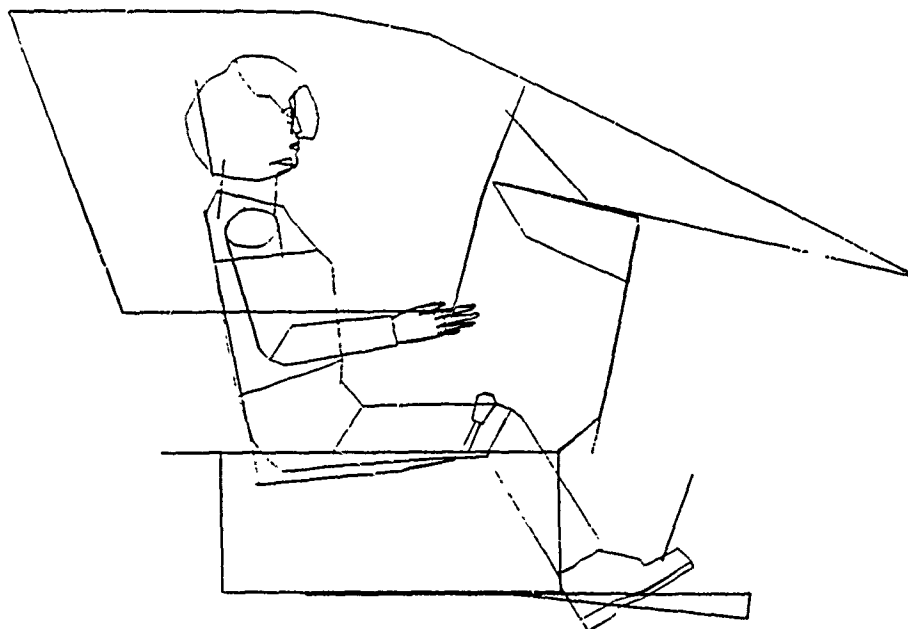


Figure 7.10. Position Reach Point. For the right arm of a two arm reach.

ACTION: Select one of the two alternatives.

- Select YES to reset the posture to the original (slumped) posture.

OR:

- Select NO after a miss by the right arm reach to terminate the function.

OR:

- Select NO after a successful right arm reach to save the posture assumed by the man-model during the right arm reach and continue the reach for the left arm. The next prompt appears.

EXAMPLE: Select NO

RESULT: (Right Arm Reach Successful) The posture assumed during the right arm reach is saved. The program returns to the Select Extent of Reach prompt. BOTHLT appears at the right of the information area to indicate that the Extent of Reach for the left arm reach is being selected (Figure 7.11). The program recycles through the same sequence for positioning the left arm reach point (BOTHLT is displayed at the right of the information area when the reach point is to be positioned for the left arm of a two arm reach). When the left arm reach is completed, successful or missed, the reach is displayed and the next prompt appears.

PROMPT: DO YOU WANT TO CONTINUE REACH? SELECT YES OR NO BELOW
YES NO

ACTION: Select one of the two alternatives.

- Select NO to terminate the function.

OR:

- Select YES to continue the reach analysis from the Extent of Reach prompt.

EXAMPLE: Select YES

RESULT: The program returns to the Select Extent of Reach prompt. BOTHRT appears at the right of the information area to indicate that the process is being repeated for the right arm. The same procedures are used as previously discussed to complete the right and left arm reaches. When the right and

SELECT EXTENT OF REACH									
REACH ANALYSIS						VIEW			
		GRIPCTR	FNCTCH	FNGRTP		BOTH LT	XY	XZ	YZ
REGRESS R67 USAF SURVEY 67 USAF		CRST		A7--SEAT					
FLIGHT SUIT SUMMER		HELMET TYPE HGU26P		POSTURE		MOBILITY		OFF-AXIS	
SEAT TYPE		HARD	OFF	0 0	2 0	0 0	SLUMPED	SHOULDER	

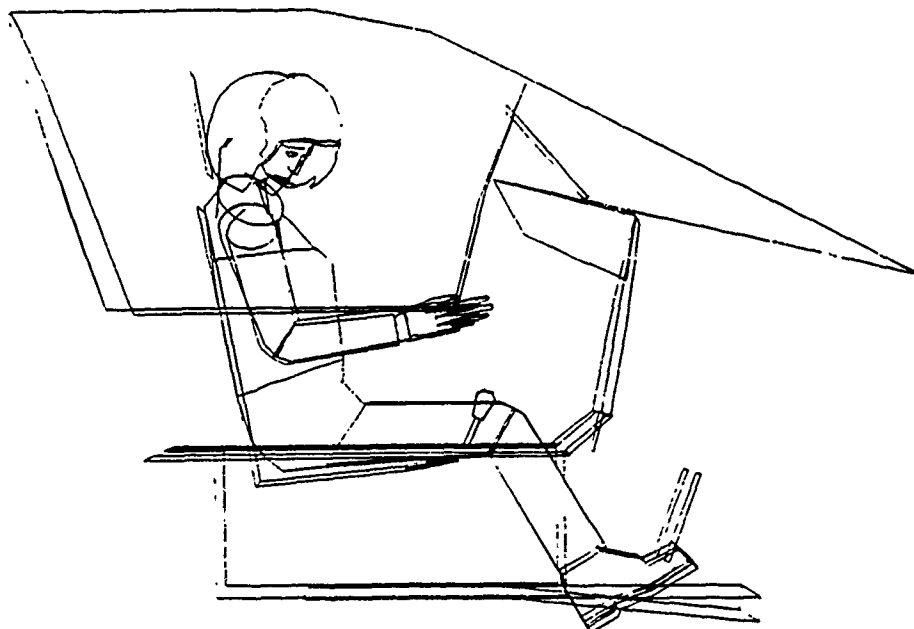


Figure 7.11. Select Extent of Reach. For the left arm of a two arm reach.

left arm reaches have been completed, the next prompt appears.

PROMPT: DO YOU WANT TO RESET POSTURE? SELECT YES OR NO BELOW
YES NO

ACTION: Select one of the two alternatives.

- Select YES to reset the program to the posture existing before the left arm reach was completed. The program returns to the Extent of Reach prompt, and the reach analysis is cycled through the procedure until a NO response prompt terminates the function.

OR:

- Select NO to terminate the function.

EXAMPLE: Select NO

RESULT: The function terminates.

7.1.3. Leg Reaches

EXAMPLE: Select RLEG

RESULT: The next prompt appears in the prompting area (Figure 7.12).

PROMPT: SELECT REACH PEDAL

ACTION: Select a RUDDER PEDAL panel from the crew station display. A panel designated as PEDAL in the crew station base must be selected. The program uses the PEDAL designation to position the instep of the foot at the center point of the lowest Z (height) line of the pedal panel.

EXAMPLE: Select the panel indicated with the arrow in Figure 7.12.

RESULT: The screen displays the man-model reaching to the pedal with the right leg. REACH SUCCESSFUL, or MISS DISTANCE and the distance missed in inches, is displayed at the right of the information area. The next prompt appears.

PROMPT: DO YOU WANT TO RESET POSTURE? SELECT YES OR NO BELOW
YES NO

SELECT REACH- PEDAL

REACH ANALYSIS		RLEG		VIEW	
		XV	YZ	YZ	
REGRESS R67	USAF SURVEY 67	USAF	CRST	A7--SEAT	
FLIGHT SUIT	SUMMER	HELMET	TYPE	HGU26P	POSTURE
SEAT TYPE	HARD	OFF	(2 0 0 0 0 0)	SLUMPED	3-SHoulder

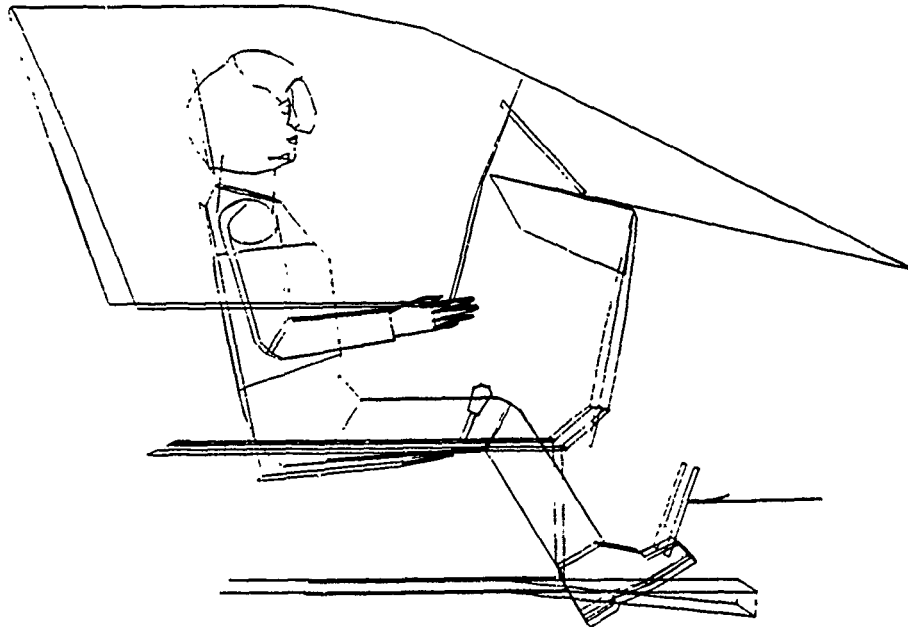


Figure 7.12. Select Reach Pedal. Select a pedal from the screen display for leg reaches.

ACTION: Make one of the two selections.

- Select YES to reset the posture to that (slumped) present before the reach was attempted.

OR:

- Select NO to terminate the function.

EXAMPLE: Select YES

RESULT: Posture resets to the original posture and the next prompt appears.

PROMPT: DO YOU WANT TO CONTINUE REACH? SELECT YES OR NO BELOW

YES	NO
-----	----

ACTION: Make one of the two selections.

- Select YES to continue the function. The program returns to the Select Reach Type prompt and the the Reach Analysis function may be repeated until a NO response terminates the function.

OR:

- Select NO to end the function.

EXAMPLE: Select NO

RESULT: The function ends.

Figure 7.13 is a flow diagram for the Perform Reach Analysis function.

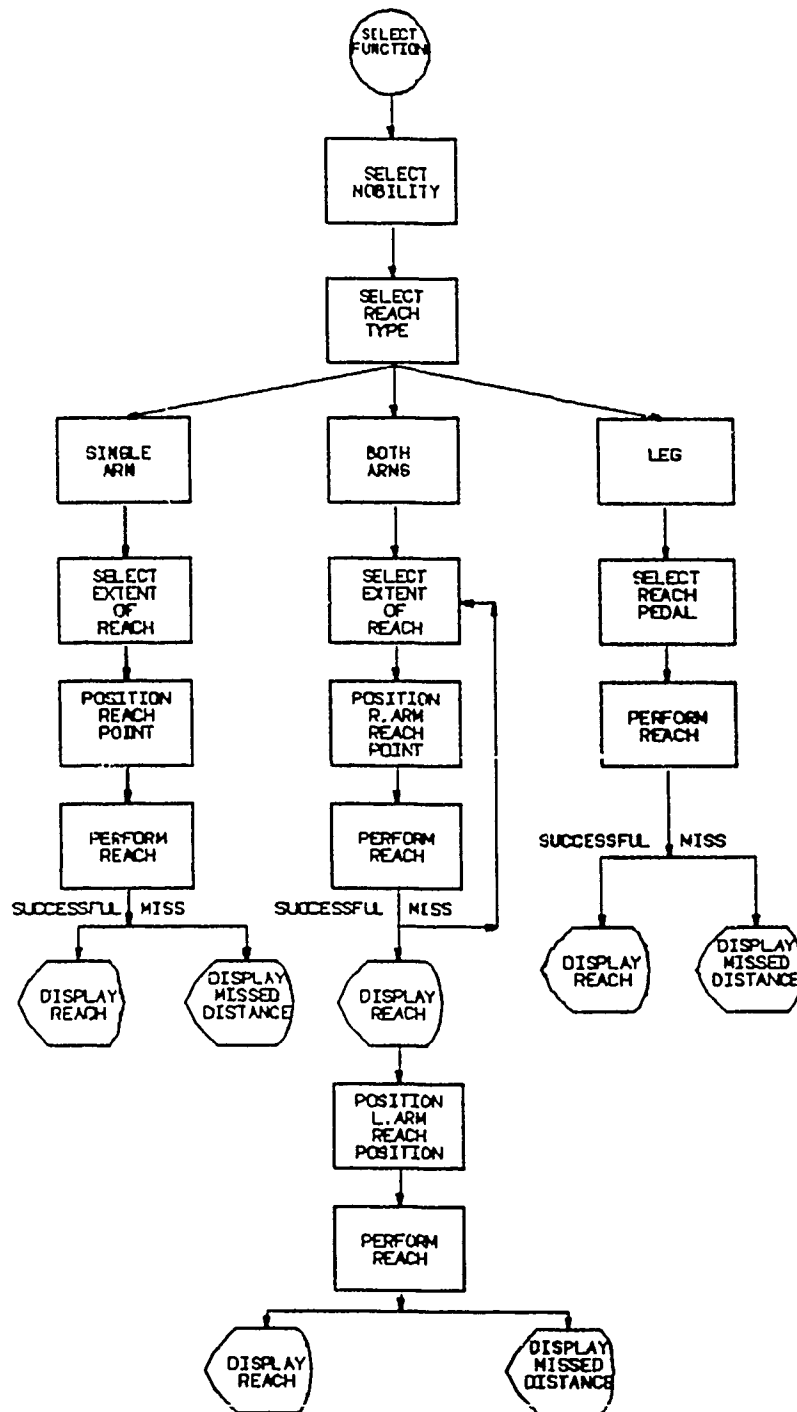


Figure 7.13. Perform Reach Analysis Function Flow Chart

7.2 REACH CURVE ANALYSIS FUNCTION (PFK 20)

The REACH CURVE ANALYSIS function of the COMBIMAN allows the user to determine if a control panel lies inside, intersects with, or lies outside the crew member's maximum arm-reach envelope. This evaluation is performed as a function of body size, clothing type, restraint type, and type of control (grip type). The function produces a reach envelope in 3-D space and then computes the intersection of that reach envelope with a user selected panel in the crew station.

This function differs from the REACH ANALYSIS function (PFK 11) in that the reach analysis is a reach to a point, with a graphic depiction of the crew member performing the reach. The REACH CURVE ANALYSIS computes a reach envelope in 3-D space and displays the intersection of that envelope with some panel (plane surface) in the crew station. The COMBIMAN is not shown reaching to any single point, because there are many points along the reach envelope intersection. As an alternative to seeing the reach curve on the display, the user can have the reach curve and crew station plotted on an on-line or an off-line plotter.

Before performing a reach curve analysis, the user should reconsider how the anthropometry of the COMBIMAN was defined and if necessary, redefine the anthropometry. For evaluating reach to hand operated controls, use the ARM LENGTH variable under the two variable method of the Define Body Size function (PFK 4). The function may be called whenever the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT FUNCTION

ACTION: Depress PFK 20

RESULT: The next prompt appears in the prompting area, with the selection menu in the display area (Figure 7.14).

PROMPT: SELECT CLOTHING TYPE

ACTION: Select the desired clothing type from the menu. The man-model displays the clothing type selected in generating the man-model with the Define Body Size function (PFK 4). The clothing type selected from this menu does not change the man-model display. It enters the change in mobility limits, due to clothing bulk and encumbrance, in the program for the Reach Curve Analysis function only.

EXAMPLE: Select WINTER SUIT W/VEST

RESULT: The next prompt appears in the prompting area (Figure 7.15).

PROMPT: SELECT GRIP TYPE

ACTION: Select one of the four grip types.

- FINGERTIP for operating push buttons.

OR:

- FUNCTIONAL GRIP for operating rotary knobs.

OR:

- HORIZONTAL FULL GRIP for operating horizontal hand grips, such as levers and handles.

OR:

- VERTICAL FULL GRIP for operating vertical hand grips, such levers and handles.

EXAMPLE: Select VERTICAL FULL GRIP

RESULT: The next prompt appears in the prompting area (Figure 7.16).

SELECT CLOTHING TYPE									
								VIEW	
								X	Y
REGRESS R67 USAF SURVEY 57 USAF CRST A7--SEAT									
FLIGHT SUIT		SUMMER		HELMET TYPE		-GJ26P		POSTURE	MOBILITY
SEAT TYPE		HARD		OFF(3 3 3 0 3 0)		ELIMPED		3-COLDER	

SEMICLAD

SUMMER SUIT

SUMMER SUIT W/VEST

WINTER SUIT

WINTER SUIT W/VEST

WINTER SUIT W/VEST JACKET AND LIFE PRESERVER

CHEMICAL DEFENSE

Figure 7.14. SELECT CLOTHING TYPE

SELECT RESTRAINT TYPE									
									VIEW
									XY XZ YZ
REGRESS	P67	USAF	SURVEY	87	USAF	CPST	A7--SEAT		
FLIGHT SUIT	SUMMER	HELVET	TYPE	WGJ26P	POSTURE	MOBILITY	OFF-AXIS		
SEAT TYPE	HARD	OFF	(	2 0	0 0	3 0)	SLYVED	9-CULDER	

LAP BELT ONLY

SHOULDER HARNESS UNLOCKED

SHOULDER HARNESS LOCKED

Figure 7.16. SELECT RESTRAINT TYPE

PROMPT: SELECT RESTRAINT TYPE

ACTION: Select desired restraint type.

- Select LAP BELT ONLY - Allows joint mobility in the upper torso, shoulder and arms. Restrictions simulate those experienced with a lap belt fastened and no shoulder harness.

OR:

- Select SHOULDER HARNESS UNLOCKED - Allows limited upper torso and shoulder mobility and unlimited arm mobility. Restrictions simulate those experienced with a lap belt fastened and shoulder harness unlocked.

OR:

- Select LOCKED - Allows limited shoulder mobility and unlimited arm mobility. Restrictions simulate the lap belt fastened, with the shoulder harness locked.

EXAMPLE: Select SHOULDER HARNESS UNLOCKED

RESULT: The next prompt appears in the prompting area (Figure 7.17). As in the Clothing Type selection, the selected restraint type does not appear in the information area. The program internally uses the limitations of the selected restraint type.

PROMPT: DO YOU WANT TO CHANGE ANY? SELECT YES OR NO
YES NO

ACTION:: Select one of the two alternatives

- Select NO if no changes are desired.

OR:

- Select YES if changes are desired in any of the three areas listed.

EXAMPLE: Select YES

RESULT: The next prompt appears in the prompting area (Figure 7.18). Listing in the display area does not change. A "NO" selection goes directly to the Select Panel prompt.

DO YOU WANT TO CHANGE ANY? SELECT YES OR NO

YES NO

VIEW

XY Z

REGRESS P67 USAF SURVEY 67 USAF CRST A7--SEAT

FLIGHT SUIT SUMMER -HELMET TYPE -GU26P POSTURE MOBILITY OFF-AXIS

SEAT TYPE -ARD OFF(J J J J J J) ELIMPED E-CULDER

WIN SUIT W/VEST

ERT FULL GRIP

SHOULDER HARNESS UNLOCKED

Figure 7.17. DO YOU WANT TO CHANGE?

SELECT TASK COMPONENT YOU WANT TO CHANGE

REPRESS 267 10AF 10PVEY 17 10AF 10PST 174-1017
10AF 10PVEY 17 10AF 10PST 174-1017
10AF 10PVEY 17 10AF 10PST 174-1017
10AF 10PVEY 17 10AF 10PST 174-1017

MIN SUIT W/VEST

LEFT FULL BRIP

SHOULDER HARNESS LOCKED

Figure 7.18. SELECT TASK COMPONENT YOU WANT TO CHANGE

PROMPT: SELECT TASK COMPONENT YOU WANT TO CHANGE

ACTION: Select any one of the three choices in the menu listing to make changes in clothing, grip or restraint type.

EXAMPLE: Select VERTICAL FULL GRIP

RESULT: Program returns to the "Select Grip Type" prompt (reference Figure 7.15). If another task component had been selected for change the appropriate "Select ----- Type" prompt would appear. When a selection is made from the displayed "Select ----- Type" menu, the program returns to the "Do You Want To Change Any?" prompt (reference Figure 7.16) with the change in selection displayed. Changes can be made until a "NO" response is made, at which time the crew station and man-model are displayed and the next prompt appears in the prompting area (Figure 7.19).

PROMPT: SELECT PANEL

ACTION: The panel to be analyzed for the Reach Curve intersection is selected from the display.

EXAMPLE: Select the panel marked with an arrow in Figure 7.19.

RESULT: The next prompt appears in the prompting area (Figure 7.20).

PROMPT: WHICH ARM SHOULD BE USED? SELECT ONE
RARM LARM BOTH

ACTION: Select one of the three choices.

- Select RARM for the Reach Curve intersection between the right arm and the selected panel.

OR:

- Select LARM for the Reach Curve intersection between the left arm and the selected panel.

OR:

- Select BOTH for the Reach Curve intersection between both arms and the selected panel. The program computes the Reach Curve intersection for both arms as the overlap area of the left and right arm Reach Curve intersections.

SELECT PANEL

										VIEW
										XV VE VE
REGRESS R67	USAF	SURVEY 67	USAF	CRST	A7--SEAT					
FLIGHT SUIT	SUMMER	HELMET	TYPE HGU26P	POSTURE	MOBILITY	OFF-AXIS				
SEAT TYPE	HARD	OFF(	0 0	0 0	0 0)	SLUMPED	3-CULDER			

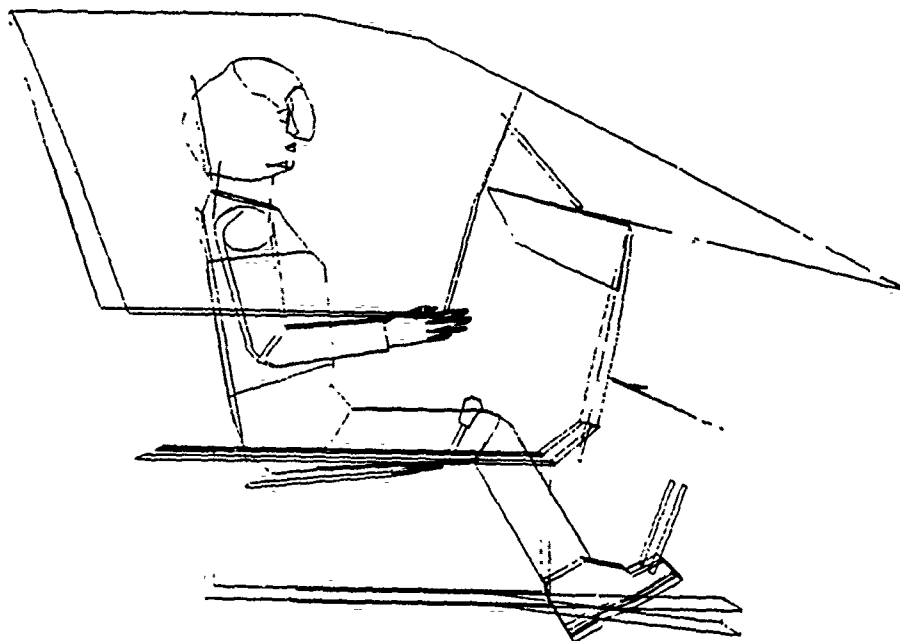


Figure 7.19. SELECT PANEL

WHICH ARM SHOULD BE USED? SELECT ONE

PARV LPM BOT-

REGRESS P67 USAF SURVEY 57 USAF CPST A7--BEAT

FLIGHT SUIT SUMMER HELMET TYPE -G026P POSTURE MOBILITY OFF-LINE

BEAT TYPE HARD OFF(3 0 3 0 3 3 : SLIPPED 3-CULDED

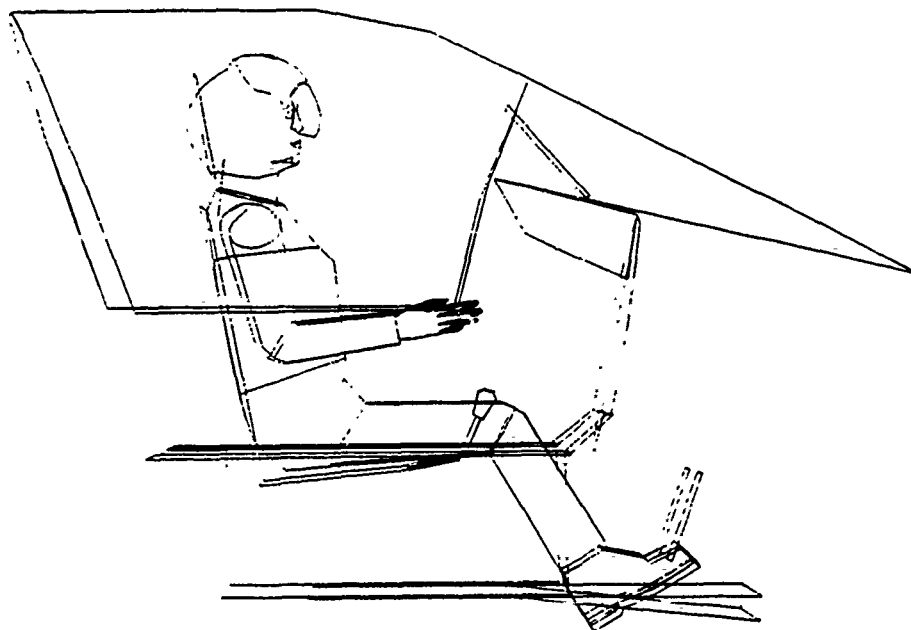


Figure 7.20. Select Arm for the Reach Curve

EXAMPLE: Select BOTH

RESULT: The message "SEARCHING FOR INTERSECTION" appears while the program is executing.

- If the entire panel is within the range of the reach curve, the message "ENTIRE PANEL WITHIN REACH" appears, followed by the function ending.

OR:

- If the entire panel is out of THE range of the reach curve, the message "PANEL NOT WITHIN REACH" appears, followed by the function ending.

OR:

- If the reach curve intersects with the panel, the next prompt appears in the prompting area, with menu selections listed in the display area (Figure 7.21).

PROMPT: SELECT PRESENTATION MODE

ACTION: Select one of the three choices.

- Select ON-SCREEN ONLY to display the Reach Curve intersection on the screen.

OR:

- Select OFF-LINE PLOT for a hard copy plot if your system has an off-line plot capability. The Reach Curve intersection is not displayed on the screen.

OR:

- Select ON-LINE PLOT for a hard copy if your system has an on-line plot capability. The Reach Curve intersection is not displayed on the screen.

EXAMPLE: Select ON-SCREEN ONLY

RESULT: The Reach Curve intersection is displayed with the crew station and the next prompt appears (Figure 7.22). It may be necessary to change the view with the Change View function (PFK 0) to see the Reach Curve intersection in the display. Figure 7.22 is a view from the off-axis values shown in the upper right of the display area. If one of the plots was selected the definition sequence begins for that plot function, as described in paragraphs 6.1 and 6.3.

SELECT PRESENTATION MODE										AREA
										<Y AC 12
REGRESS	P67	USAF	SURVEY	67	USAF	CRST	A7--SEAT			
FLIGHT	SUIT	SUMMER	HELMET	TYPE	-3026P	POSTURE	MOBILITY	OFF-1113		
SEAT	TYPE	HARD	OFF	3 2	3 2	3 2	FLMPED	3-1113		

ON-SCREEN ONLY

ON-LINE PLOT

OFF-LINE PLOT

Figure 7.21. SELECT PRESENTATION MODE

PROMPT: ERASE CURVE? SELECT YES OR NO
YES NO

ACTION: Make one of the two selections.

- Select YES if there is not a requirement to retain the Reach Curve intersection in the display.

OR:

- Select NO if Reach Curve intersection is to be retained in the drawing. A "NO" selection retains the Reach Curve intersection as a panel in the crew station for the remainder of the run, or until deleted with the Delete Panel function (PFK 18). It can also be retained as a permanent part of the crew station with the Save Current Crew Station function (PFK 10).

EXAMPLE: Select YES

RESULT: The Reach Curve intersection is removed from the display and the function ends. If NO had been selected the Reach Curve intersection is retained in the display, and the function ends.

NOTE: If you want to inspect the Reach Curve intersection on the screen and also obtain a hard copy plot, select NO as the response to the "Do You Want to Erase Curve?" prompt. When the function ends select the On-Line or Off-Line Plot function (PFK 8 or PFK 7), as appropriate for your system. A hard copy plot, including the Reach Curve intersection, will be made. The Reach Curve intersection can then be removed from the display with the Delete Panel function (PFK 18).

Figure 7.23 is the flow chart for the Reach Curve Analysis function.

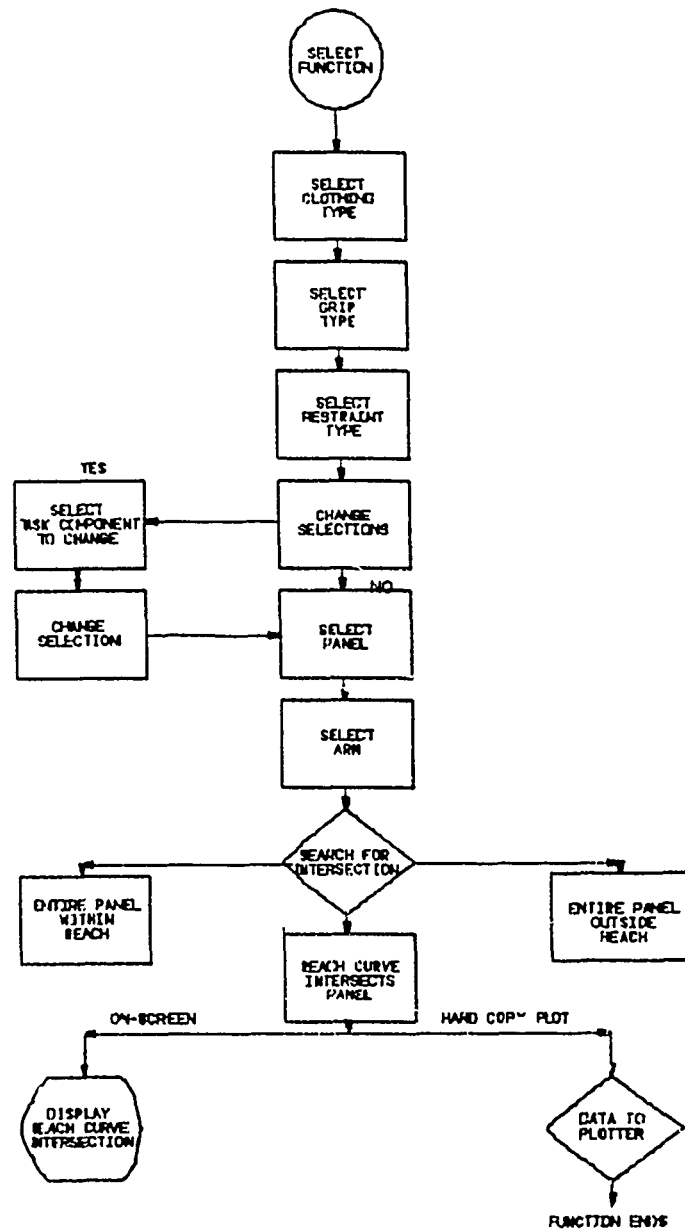


Figure 7.23. Reach Curve Analysis Function Flow Chart.

7.3 STRENGTH ANALYSIS FUNCTION (PFK 19)

The Strength Analysis function computes and displays the maximum amount of strength (force) a crew member is capable of exerting on a control. Strength capability depends not only on the muscular strength characteristics of a person or a population, but also on task-related factors such as location of the control relative to the operator's location and body size, the direction of the force exerted, acceleration forces, and the duration of the exertion.

The data modeled in this function represent male or female USAF crew members only. Similar strength data are currently unavailable for the Army and Navy populations, and the Strength Analysis function cannot be executed if these populations were used to define the body size. If this occurs, the message "STRENGTH DATA ONLY AVAILABLE FOR R67 USAF AND R68 AFFW SURVEYS" appears briefly in the prompting area and the function ends. The strength data are for short (5 second) static exertions. Two data bases have been combined to represent most locations reachable in a crew station. One modeled data base represents male and female pilots operating traditional aircraft controls: stick and wheel type aileron and elevator, and rudder pedals. The other data base models maximum forces up, down, left, right, fore, and aft for 76 different handle locations within the seated crew station. These 76 locations cover the forward area above the seat reference point level. The Strength Analysis function interpolates between these locations to provide the best estimate

of strength capability for any point the user selects. These data bases have been merged in such a way that the user receives the results for a specific location, gender, and type of control specified. So, if the user changes the control location, or the direction of force applied, the results will be different.

Because the variables of body size and strength are not highly correlated, they are treated independently in strength analysis. In other words, defining a larger body size for the COMBIMAN man-model will not by itself produce a greater strength. The strengths are displayed under a column headed FMAG, representing the population as a whole and not the body size the user has defined, and are forces in pounds representing the strength capabilities of the 1st, 5th, 50th, 95th, and 99th percentiles of USAF male or female pilot populations. One factor that does affect strength, however, is the location and orientation of the control relative to the operator's orientation. Therefore, body size is considered in that the same control will have a slightly different relative location for small and large operators.

The design philosophy is to accommodate the 5th and 95th percentile male or female strength capability as appropriate, and to accommodate the 1st and 99th percentile strength capability where critical functions are involved. The upper percentiles of strength may be useful in designing the "break strength" requirements for controls.

The Strength Analysis function is based on the prerequisite that force cannot be applied to a control unless the control can

be reached. In general, force data are available for points that can be reached in the forward hemisphere of the crew station. In some cases, at maximum reach extents, points can be reached but are outside the range of the strength data. In such instances, the message "OUT OF RANGE OF AVAILABLE STRENGTH DATA" appears briefly and the function terminates.

The structure of the strength data base, due to the procedures used in collecting the data, allows only certain combinations of control type, force direction, hand(s) used and body mobility. The program structure allows only choices compatible with the strength data base (Figure 7.24). In some cases there is no choice available, and in these instances the default condition is presented in the prompt. The function may be called at any time that the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK19 to initiate the Strength Analysis function.

RESULT: The prompts and menus for selecting control type and force directions are displayed, with the defaults listed to the right of the prompts.

PROMPT: SELECT CONTROL TYPE: (Prompt and choices in upper half of display area)

ACTION: Select the control type to be used for the analysis. LEVER is the default control type and appears at the right of the prompt (Figure 7.25). There are three options available.

- Accept the default control type and proceed to the next prompt.

OR:

- Select one of the other types from the menu.

CONTROL TYPE	FORCE DIRECTIONS				HAND	MOBILITY
	LEFT/ RIGHT	FORE/ AFT	LEFT TURN/ RIGHT TURN	UP/ DOWN		
LEVER	X	X		X	L R	L
WHEEL			X		L R B	L
WHEEL		X			B	L
STICK	X	X			L R	L
EJECT-S				UP	L R B	S
EJECT-C				UP	L R B	S
PEDAL		FORE			L R (LEG)	

HAND: L = LEFT HAND, R = RIGHT HAND, B = TWO HAND
MOBILITY: L = LAP BELT, S = SHOULDER
EJECT-S = EJECT-SIDE, EJECT-C = EJECT-CENTER

Figure 7.24. Choices Available for Control Type.

***** STRENGTH ANALYSIS FUNCTION *****

SELECT CONTROL TYPE LEVER

LEVER

WHEEL

PEDAL

STICK

EJECT - SIDE

EJECT - CENTER

SELECT FORCE DIRECTION LEFT

LEFT

RIGHT

UP

DOWN

FORCE

LEFT

CONTINUE /

Figure 7.25. Control Type and Force Direction Selection Menus
with LEVER Control Type Selected.

OR:

- Depress <CR> to exit the function.

Examples for LEVER, EJECT-, and PEDAL are given in the following paragraphs.

7.3.1 LEVER Control Type Selected

PROMPT: SELECT CONTROL TYPE: LEVER (Upper prompt)

ACTION: No action required to select LEVER as it is the default. Proceed to the next prompt.

RESULT: No change in subsequent prompts and menus on this page.

PROMPT: SELECT FORCE DIRECTION: LEFT (Middle prompt)

ACTION: Select desired force direction from the menu.

- Accept the default and go to the bottom prompt.

OR:

- Select another force direction from the menu.

OR:

- Depress <CR> to exit the function.

EXAMPLE: Select AFT

RESULT: AFT appears to the right of the prompt. Proceed to the bottom prompt

PROMPT: /CONTINUE/

ACTION: The user may change either the control type or force direction by making other selections from the menus. Once the desired control type and force direction appear to the right of the appropriate prompt, select /CONTINUE/.

RESULT: The next menus and prompts are displayed. Note that the control type and force direction previously selected appear at the top of the screen. Defaults for the menus appear to the right of the prompts (Figure 7.26).

***** STRENGTH ANALYSIS FUNCTION *****

CONTROL TYPE LEVER

FORCE DIRECTION AFT

SELECT REACH RIGHT HAND

LEFT HAND

RIGHT HAND

SELECT MOBILITY LAP BELT

/ CONTINUE /

Figure 7.26. Reach and Mobility Selection Menus with LEVER Control Type Selected.

PROMPT: SELECT REACH: RIGHT HAND (Upper prompt)

ACTION: Select the hand to perform the reach.

- Accept the default (RIGHT HAND) and go to the next prompt.

OR:

- Select LEFT HAND.

EXAMPLE: Select LEFT HAND

RESULT: LEFT HAND appears to the right of the prompt, indicating the reach hand selected. Continue to the next prompt.

PROMPT: SELECT MOBILITY: LAP BELT (center prompt)

ACTION: There is no choice as the strength data for LEVER control types was collected with the LAP BELT only. LAP BELT allows arm, shoulder and torso movement as with a lap belt only. Proceed to the next (bottom) prompt.

PROMPT: /CONTINUE/ (Bottom prompt)

ACTION: The Reach selections may be changed by making selections from the appropriate menus. Once the desired Reach selection is made and displayed to the right of the prompts, select /CONTINUE/.

RESULT: A side view of the man-model and crew station is displayed, with a movable cursor (+) positioned at the seat reference point. The Mobility and selected Reach are displayed at the right side of the information area (Figure 7.27) The next prompt is displayed in the prompting area and the PFKs are temporarily re-defined.

PROMPT: POSITION REACH POINT

ACTION: Set the X and Z coordinates of the reach point using the procedures in paragraph 7.1.1 with the redefined PFK's in Figure 7.6.

EXAMPLE: Position the cursor for the following coordinate values; X = 19.70, Z = 6.60, followed by depressing PFK 31 (RECORD).

RESULT: A front view of the man-model and crew station is displayed, with the cross hair at the point selected when the X and Z coordinates were set.

STRENGTH ANALYSIS		POSITION REACH POINT		VIEW						
REGRESS	P67	USAF SURVEY	67	USAF	CPST	A7--SEAT	GRIPCTR	XY	XZ	YZ
FLIGHT SUIT	SUMMER	HELMET	TYPE	LG026P	POSTURE	MOBILITY	OFF--1.13			
SEAT TYPE	HARD	OFF	(	0 0	0 0	0 0)	SLOPED	LAP BELT		

REACH POINT

X	Y	Z
0 0	0 0	0 0

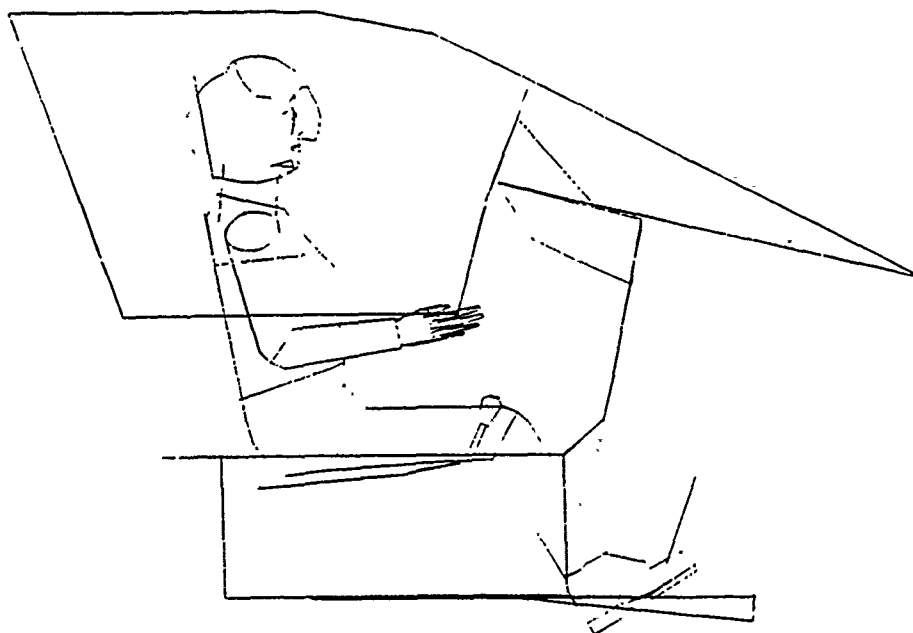


Figure 7.27. Position Reach Point for Setting X and Z Coordinate Values.

The values set for the X and Z coordinates are displayed in the upper left corner of the display area (Figure 7.28). Prompt remains the same.

PROMPT: POSITION REACH POINT

ACTION: Set the Y and/or Z coordinates of the reach point using the procedures in paragraph 7.1.1 with the redefined PFK's in Figure 7.6.

EXAMPLE: Position the cross hair for the following Y coordinate value, Y = 12.70, and then depress PFK 31 (record).

RESULT: There are three possible results:

Result 1:

- The point selected is within the reach envelope, but is outside the strength data base range. In this situation the message "OUT OF RANGE OF AVAILABLE STRENGTH DATA" appears briefly in the prompting area and then the function terminates.

OR:

Result 2:

- The designated reach point cannot be reached. For this case, a message "MISS DISTANCE", with the miss distance in inches below it, appears at the right side of the information area. The following prompt appears.

PROMPT: DO YOU WANT TO RESET POSTURE? SELECT YES OR
NO BELOW

YES

NO

ACTION: Select one.

- Select YES to reset to the original (slumped) posture.

OR:

- Select NO to terminate the function.

EXAMPLE: Select YES

RESULT: Posture resets to 'slumped' and the next prompt appears.

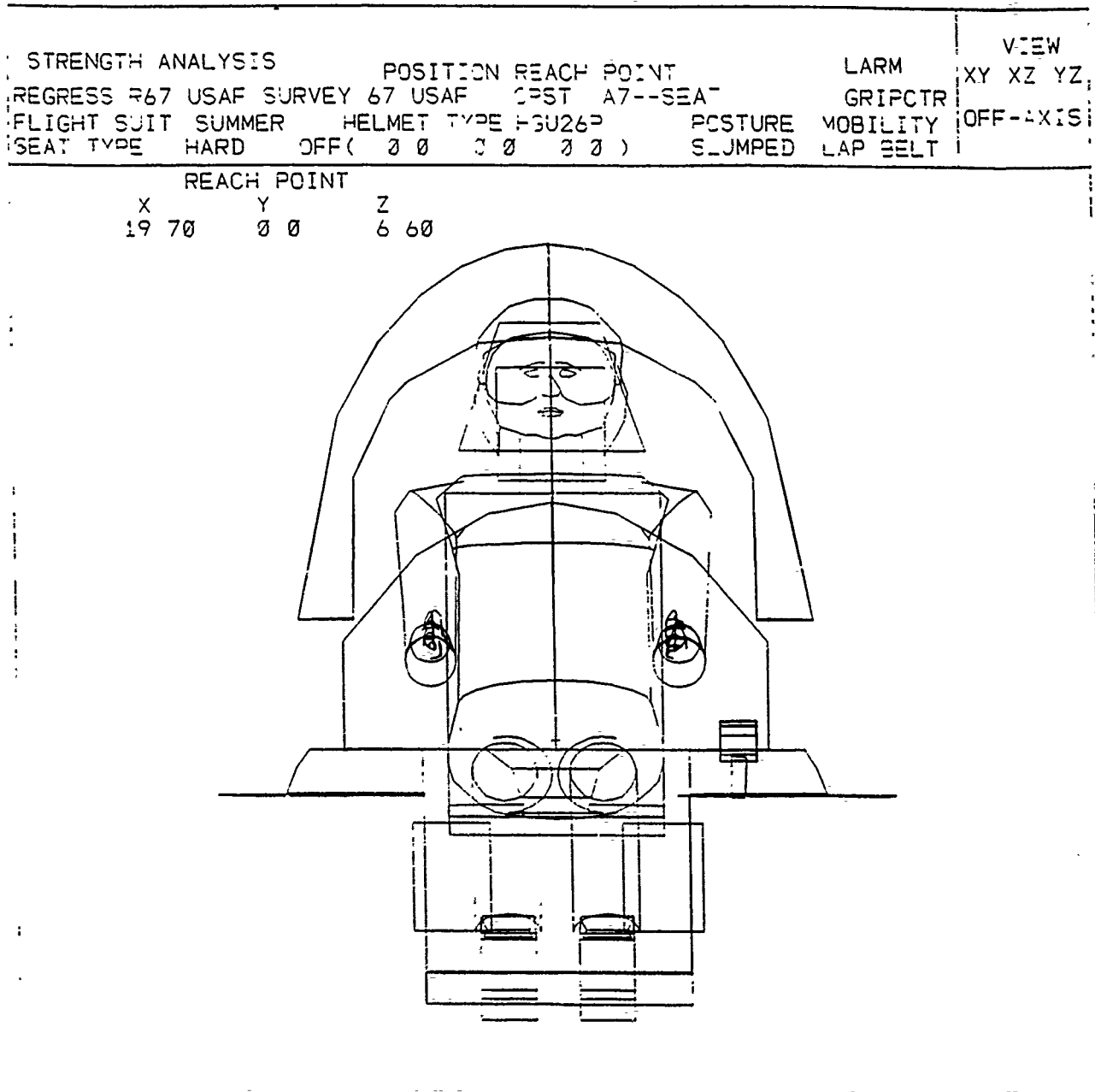


Figure 7.28. Position Reach Point for Setting Y Coordinate Value

PROMPT: DO YOU WANT TO CONTINUE REACH? YES OR NO
YES NO

ACTION: Select one of two choices.

- Select YES to continue the strength analysis.

OR:

- Select NO to end the function.

EXAMPLE: Select YES

RESULT: The program returns to the SELECT REACH menu. This allows the user the opportunity to change the Reach and/or the Reach Point. If changed selections result in a Successful Reach that is within the strength data base range, the program will display the strength data.

OR:

Result 3:

- If the point can be reached, and is within the strength data base range, the screen displays the man-model reaching to the point, the control type and force direction in the upper left corner of the display area, and the mobility at the right of the information area. The strength capability is displayed in the upper right corner of the display area (Figure 7.29). For the Lever control, FMAG is the resultant force that can be applied, and the X, Y, and Z components (relative to the COMBIMAN SRP coordinates) of that resultant force are also displayed. These are useful for understanding the extraneous forces that operators exert on controls. For example, if a person lifts a control handle, a lateral and longitudinal force may also be exerted because of the relationship of the shoulder or seat support relative to the control resistance. These forces are smaller in magnitude than the resultant, but should be considered if the control is sensitive, or not strong, in other axes. By providing these components, the user can compute the direction of the resultant, if desired. The next prompt is displayed in the prompting area.

PROMPT: ENTER <CR> TO EXIT FUNCTION

ACTION: Enter <CR>

RESULT: Function is terminated.

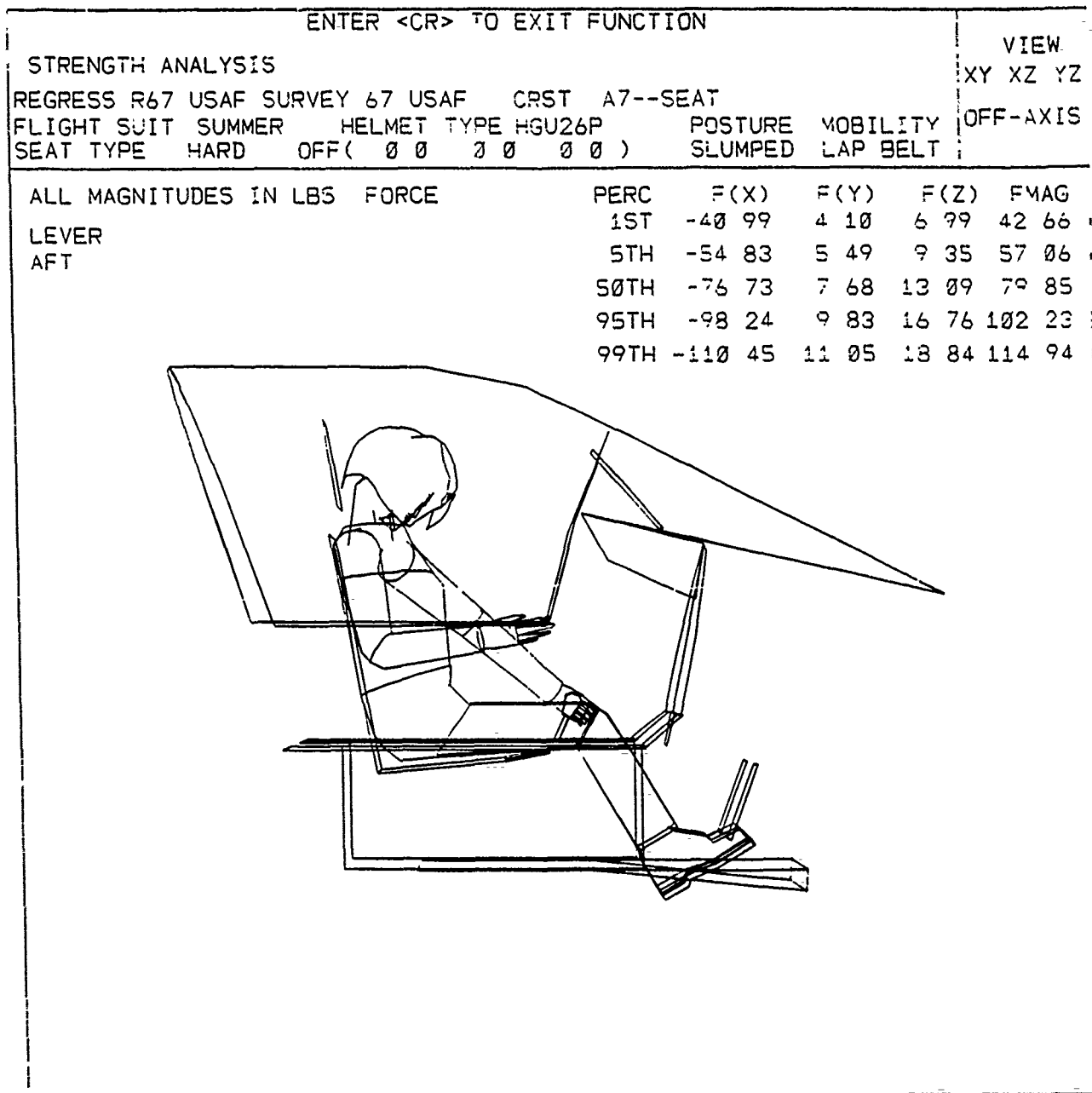


Figure 7.29. Strength Display for LEVER Control Type.

7.3.2. EJECT Control Type Selected

The reach and strength data bases for the ejection seat control type are based on the ACES II ejection seat. Provisions are made for both side- and center-mounted ejection handles.

PROMPT: SELECT CONTROL TYPE: LEVER (Upper prompt)

ACTION: Select either of the EJECT- type controls.

- Select EJECT-SIDE for side mounted ejection handles

OR:

- Select EJECT-CENTER for center mounted ejection handle

EXAMPLE: Select EJECT-SIDE

RESULTS: EJECT-SIDE appears to the right of the prompt. The Select Force Direction prompt defaults to UP, which is the only force direction for the ejection seat control type (Figure 7.30). Proceed to the bottom prompt.

PROMPT: /CONTINUE/ (Bottom prompt)

ACTION: The Control Type and Force Direction may be changed by making selections from the appropriate menus. When the desired Control Type and Force Direction appear to the right of the prompts, select /CONTINUE/.

RESULT: The next menus and prompts appear. The control type and force are displayed at the top of the screen, and the defaults for subsequent selections appear to the right of the prompts (Figure 7.31).

PROMPT: SELECT REACH: RIGHT HAND (Upper prompt)

ACTION: Select the hand(s) to reach the ejection handle seat handle(s).

- Accept the default (RIGHT HAND) by proceeding to the next prompt.

***** STRENGTH- ANALYSIS FUNCTION *****

SELECT CONTROL TYPE EJECT - SIDE

LEVER

WHEEL

PEDAL

STICK

EJECT - SIDE

EJECT - CENTER

SELECT FORCE DIRECTION =

CONTINUE /

Figure 7.30. Control Type and Force Direction Selection Menus with EJECT- Control Type Selected.

***** STRENGTH ANALYSIS FUNCTION *****

CONTROL TYPE EJECT - SIZE FORCE DIRECTION UP

SELECT REACH- RIGHT -AND

LEFT -AND

RIGHT -AND

TWO -AND

SELECT MOBILITY . ARV

/ CONTINUE /

Figure 7.31. Reach and Mobility Selection Menus for EJECT-Control Type.

OR:

- Select a different hand(s) to reach to the ejection handles from the menu.

OR:

- Depress <CR> to terminate function.

EXAMPLE: Accept the RIGHT HAND(default) by going to the next prompt.

RESULT: No changes to the screen display.

PROMPT: SELECT MOBILITY: SHOULDER (Middle prompt)

ACTION: No action is required or allowed as SHOULDER is the default. SHOULDER allows arm and shoulder movement only, as with a locked shoulder harness. All ejection seat reach and strength data are predicated on the shoulder harness locked condition. Go to the next prompt.

PROMPT: /CONTINUE/ (Bottom prompt)

ACTION: Reach selection may be changed by selecting a different hand(s) from the menu. Once the desired hand(s) selection appears to the right of the prompt, select /CONTINUE/.

RESULT: The man-model is displayed reaching to the ejection handle locations established in the crew station data base. Strength capability is displayed in the upper right corner of the display area, with the next prompt in the prompting area (Figure 7.32).

PROMPT: ENTER <CR> TO EXIT FUNCTION

ACTION: When ready to exit function, enter <CR>.

RESULT: The function terminates.

```

ENTER <OP> TO EXIT FUNCTION

STRENGTH- ANALYSIS
REGRESS P67 USAF SURVEY 67 USAF CRST A7--SEAT
FLIGHT SUIT SUMMER HELMET TYPE -3026P POSTURE MOBILITY CFF-1/13
SEAT TYPE -LAPD CFF( 2 2 0 0 0 0 ) FLYPED 3-SHoulder

ALL MAGNITUDES IN INCH-LBS OF TORQUE
EJECT - SIDE
PERC  PMAG
13TH 327 11
5TH 367 11
50TH 522 11
85TH 700 11
95TH 711 11

```

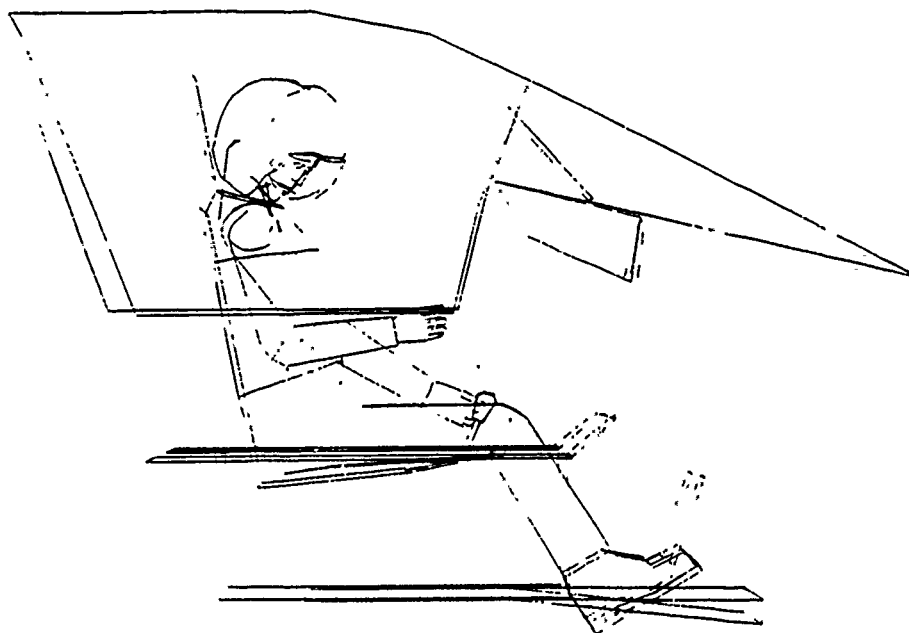


Figure 7.32. Strength for EJECT- Control Type, and EXIT Function Prompt

7.3.3 PEDAL Control Type Selected

PROMPT: SELECT CONTROL TYPE: LEVER (Upper prompt)

ACTION: Select PEDAL

RESULT PEDAL appears to the right of the prompt, and the Select Force Direction prompt defaults to FORE. No other force directions are available, as only a forward force may be applied to a pedal (Figure 7.33). Proceed to bottom prompt.

PROMPT: /CONTINUE/

ACTION: Select /CONTINUE/

RESULT: Next prompts and menus are displayed. Control type currently selected and default force direction appear at the right of the prompts. No mobility selections are made for a PEDAL strength analysis, as the mobility limits have no effect on leg reach (Figure 7.34).

PROMPT: SELECT REACH: LEFT LEG (Upper prompt)

ACTION: Select the leg to reach to the pedal.

- Accept the default by proceeding to the bottom prompt.

OR:

- Select another leg from the menu.

EXAMPLE: Select RIGHT LEG

RESULT: RIGHT LEG appears to the right of the prompt. Go to the bottom prompt.

PROMPT: /CONTINUE/ (Bottom prompt)

ACTION: The REACH selection may be changed by selecting another choice from the menu. Once the desired choice appears to the right of the prompt, select /CONTINUE/.

RESULT: The man-model and the crew station are displayed in the side view. The leg selected for the reach appears at the right of the information area. The next prompt appears in the prompting area.

***** STRENGTH ANALYSIS FUNCTION *****

SELECT CONTROL TYPE PEDAL

LEVER

WHEEL

PEDAL

STICK

EJECT - SIDE

EJECT - CENTER

SELECT FORCE DIRECTION FORE

CONTINUE /

Figure 7.33. Control Type and Force Direction Selection Menus with PEDAL Control Type Selected.

***** STRENGTH ANALYSIS FUNCTION *****

CONTROL TYPE PEDAL

FORCE DIRECTION FORE

SELECT REACH LEFT LEG

LEFT LEG

RIGHT LEG

/ CONTINUE /

Figure 7.34. Reach Selection Menu with PEDAL Control Type Selected.

PROMPT: SELECT REACH PEDAL

ACTION: Select the pedal panel to be reached for the strength analysis. The panel selected must have been designated as a "Pedal" type panel when included in the Crew Station data base. The program uses the "Pedal" type designation to properly place the foot on the pedal.

EXAMPLE: Select the "Right Pedal" panel from the screen display (indicated by an arrow in Figure 7.35).

RESULT: Strength data are presented in the upper right corner of the display area (Figure 7.36). The next prompt appears in the prompting area. If the pedal had been beyond the leg reach, or out of range of the strength data base, similar messages and prompts as previously discussed would be displayed. The next prompt appears.

PROMPT: ENTER <CR> TO EXIT FUNCTION

ACTION: Enter <CR>

RESULT: Function terminates.

Figure 7.37 is the flow chart for the Strength Analysis function.

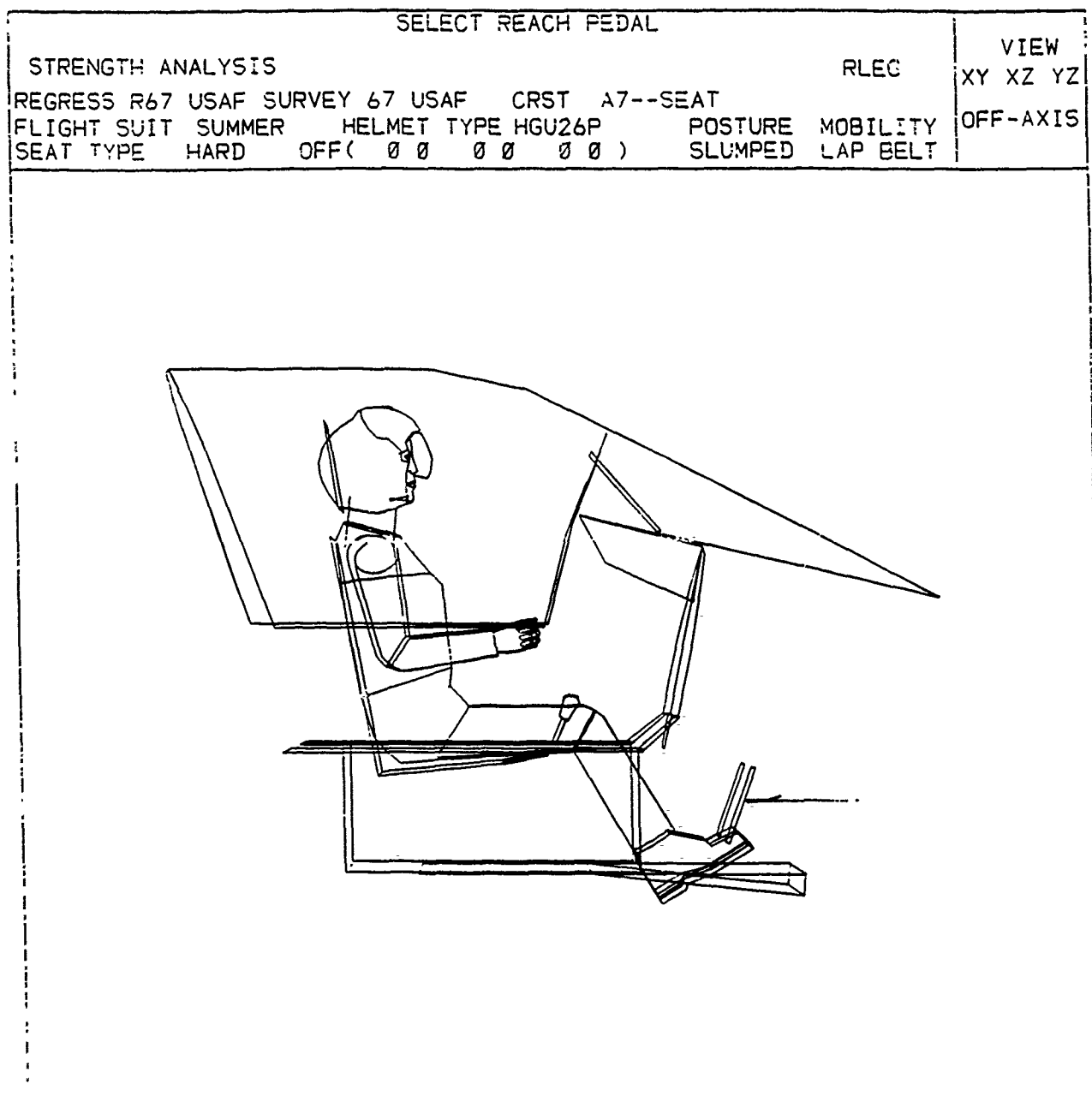


Figure 7.35. SELECT REACH PEDAL

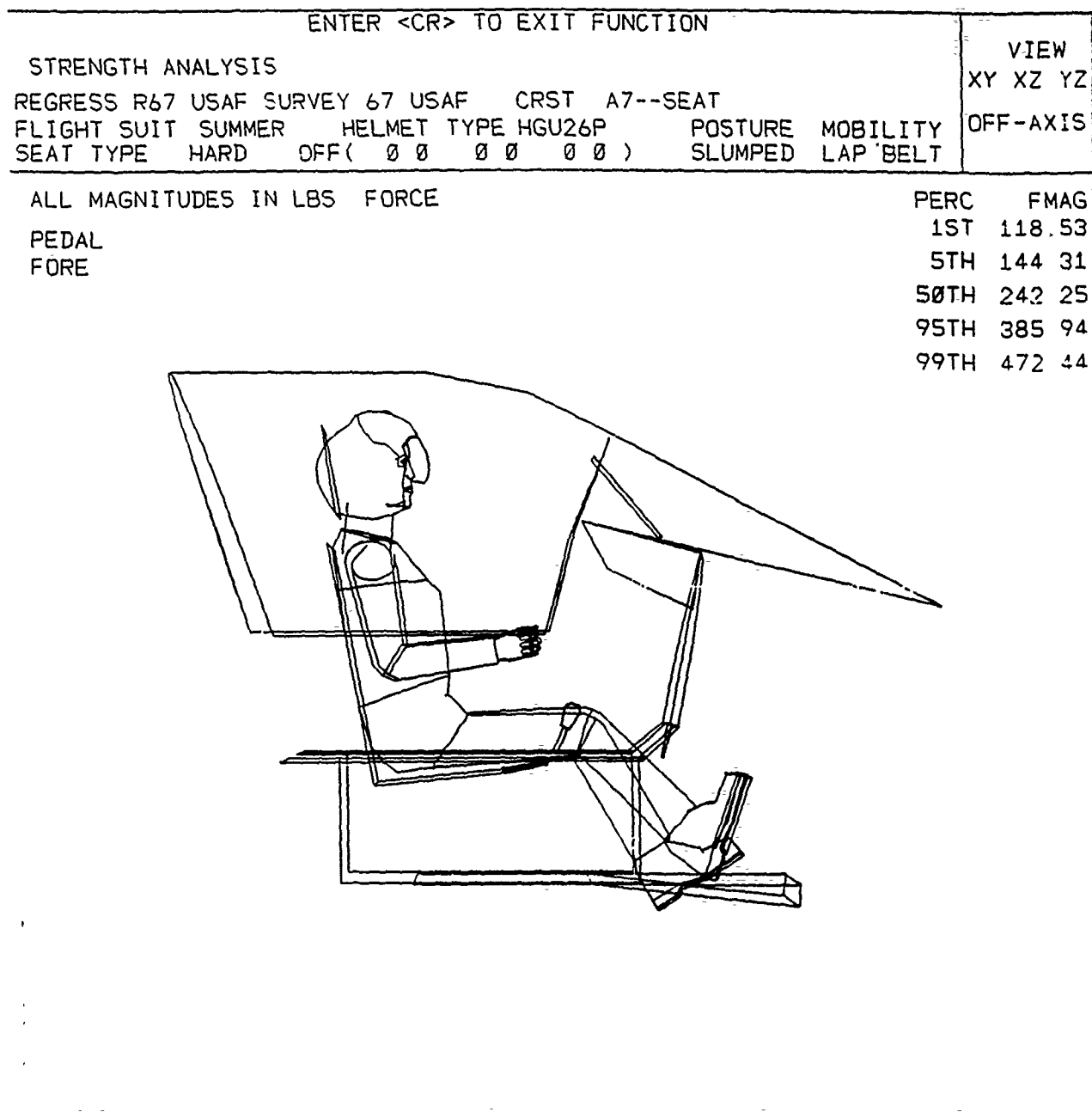


Figure 7.36. Pedal Force Display, and EXIT Function Prompt

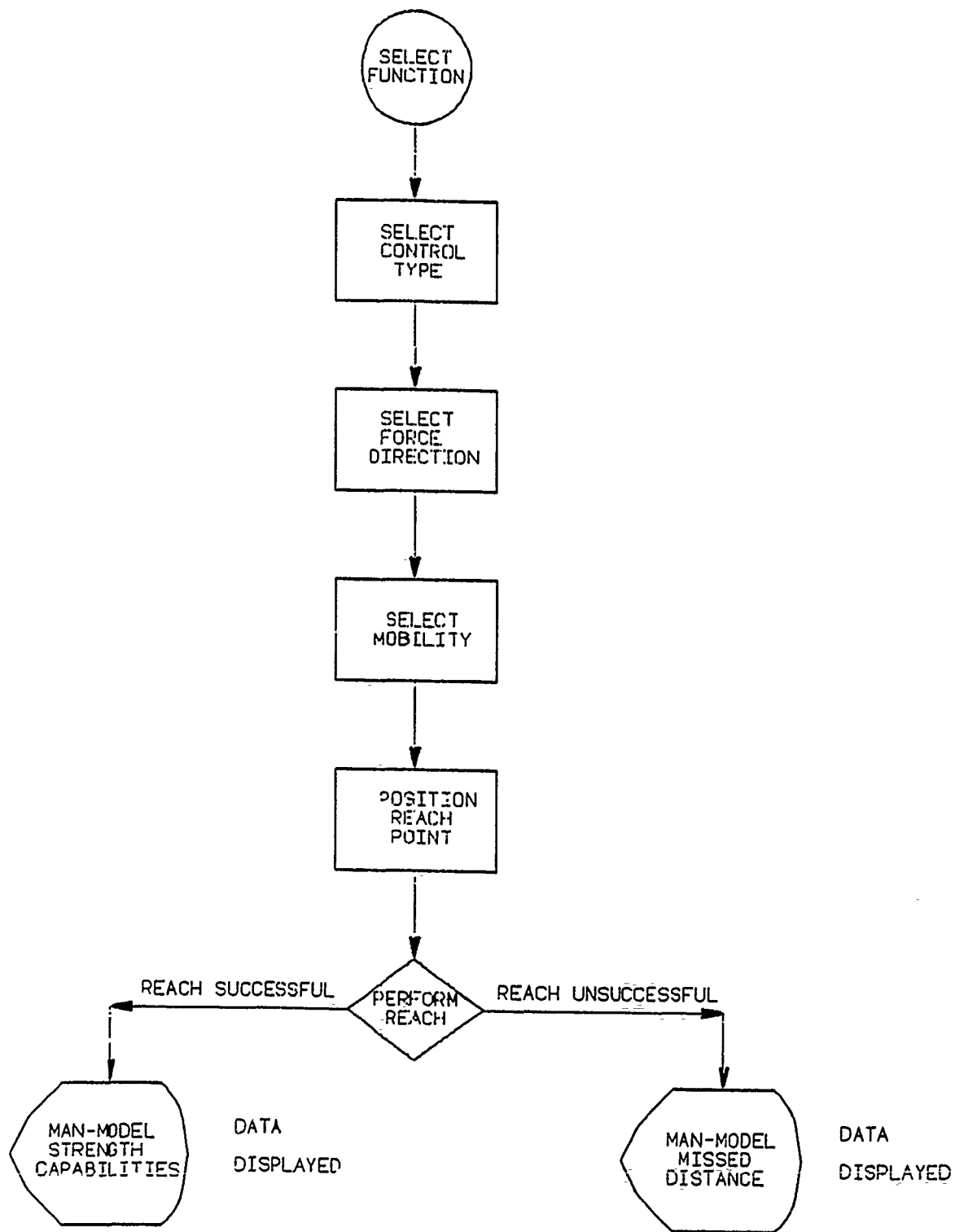


Figure 7.37. Strength Analysis Function Flow Chart.

7.4 VISIBILITY ANALYSIS FUNCTION (PFK 6)

The Visibility Analysis function (PFK 6) generates and plots a map of the angular line-of-sight (LOS) to objects in the crew station, or even outside the crew station if the data base is so defined. MIL-STD-850 requires visual angle maps be made of the crew station to demonstrate that the pilot has adequate vision through the window. Two formats are allowed by MIL-STD-850: rectilinear and Aitoffs. The Visibility Analysis function uses the rectilinear format.

While the MIL-STD-850 requires that the plot of LOS be forward and with respect to the design eye position, the flexibility of COMBIMAN gives the user that and many other options and capabilities:

(1) Eye position defined by movable head. The head can be moved away from forward looking in two ways: first, by changing the angles of the head or neck with the Display Link Table (PFK 14) function; and second by performing a reach analysis with the Perform Reach function (PFK 11), as COMBIMAN's head looks at the point selected as the reach target. So if the user desires the COMBIMAN to look at a specific object, that object can be identified as a point to be reached. The point does not have to be within the acceptable arm reach to accomplish the automatic head repositioning.

(2) Eye position defined by variable body size. The eye location relative to the seat is a function of sitting eye height. The user can adjust this using the Define Body Size function (PFK 4).

(3) Eye position modified by seat adjustment. This is a powerful method of adjusting the entire seat-pilot combination. The seat can be adjusted in three dimensions without limit, even to locations outside the immediate crew station.

(4) Visibility Limit Overlays to show the effect of personnel protective equipment worn on the head, such as helmets, masks, goggles, etc.

(5) Changeable plot size to accommodate the user's needs.

Because the Visibility Analysis function works from a user created data base, the "crew station" can be anything the user wishes to define, not just an aircraft cockpit. Objects outside the crew station can be entered into the data base and plotted. For example, other aircraft in a formation, wings or other structure on the aircraft, a refueling aircraft, a runway the pilot is landing on. All that is required is that these objects be entered into the data base in the appropriate coordinate system.

Three Vision Overlays are included in the data base on the distribution tape. They are Base Line, HGU-26P & MBU-59, and Field of Resolution. The Base Line overlay depicts the unrestricted field of peripheral vision. The HGU-26P & MBU-59 overlay depicts the visibility obscuration of the standard Air Force helmet and oxygen mask. The Field of Resolution portrays the limits of visual acuity. Twelve more overlays may be added using the procedures in Appendix C.

The plot may be displayed on the screen, or hard copies of the plot may be made. Setting State Switch 6 to "ON" with the State Switch function (PFK 29), prior to calling the Visibility Analysis function, allows the hard copy plot size to be changed.

If State Switch 7 is set to "ON", prior to calling the Visibility Analysis function, the routine also calculates and prints a cross reference listing of the three dimensional coordinates of the objects plotted, in five degree azimuth, from - 180 to + 180 degrees from the horizontal line of sight for

each panel and/or control. This listing is a handy reference to the location of objects in the crew station drawing. The coordinates are given in both the user defined, and the COMBIMAN, systems of coordinates. The Visibility Analysis function may be called whenever the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 6 to call the Visibility Analysis function.

RESULT: The Visibility Analysis function selection menu appears (Figure 7.38). The visibility overlays are defaulted to and projected from the middle eye location, which is equidistant between the two eyes. This location is listed for information only. If visibility overlays are added to the data base (see Appendix C) they will be included in the menu for selection.

PROMPT SELECT UP TO FOUR OVERLAYS (upper prompt)
(*ERASE*)

ACTION: Select the desired overlay(s). Selections are highlighted on the screen to indicate selection. If more than one is selected, each becomes highlighted as it is selected. Up to four overlays may be included in an analysis. If more than four are selected, the first one selected will become dim, indicating it is no longer selected. If any selection is highlighted that is not desired, select "(*ERASE*)" and all choices will be canceled, as indicated by the highlighting disappearing.

EXAMPLE: Select HGU-26P & MBU-59

RESULT: "HGU-26P & MBU-59" is highlighted on the screen, indicating program selection. When the desired overlays have been selected continue to the next prompt.

PROMPT: SELECT OPTION FOR TYPE OF PLOT (bottom prompt)
PLOT ON SCREEN ON-LINE PLOT OFF-LINE PLOT

***** VISIBILITY FUNCTION *****

EYE LOCATION

MIDDLE

SELECT UP TO FOUR OVERLAYS

(* ERASE *)

BASE LINE

HGU-26 & MBU-5/P

FIELD OF RESOLUTION

SELECT OPTION FOR TYPE OF PLOT

PLOT ON SCREEN

ON-LINE PLOT

OFF-LINE PLOT

SELECT OVERLAYS AND THEN SELECT THE PLOT OPTION

Figure 7.38. Visibility Analysis Function Selection Menu

ACTION: Select the plot type desired.

- Select "PLOT ON SCREEN" for a display of the plot of the vision limits on the screen.

OR:

- Select "HARD COPY" to obtain a hard copy of the plot from the system plotter.

EXAMPLE 1: Select PLOT ON SCREEN

RESULT: The plot is displayed on the screen, with the message "DEPRESS CR TO CONTINUE". Depressing <CR> ends the function.

EXAMPLE 2: Select ON-LINE PLOT or OFF-LINE PLOT, depending on the type plotting capability of your system.

RESULT: The result depends on the status of State Switch 6. If State Switch 6 is "OFF" (default setting) no further action is required, and the information is sent to the system plotter and the function ends. If State Switch 6 is "ON" the following prompt appears.

PROMPT: ENTER SCALE FACTOR FOR VISIBILITY PLOT

ACTION: To change plot size, enter a value from 0.1 to 2.5 on the ANKB< followed by <CR>. When using the 22 inch Versatec plotter, the default scale factor is 1.0 and the size of the visibility plot is 0.04 inches per degree, or a plot of 7.2 x 14.4 inches. For a scale factor of 0.5, the plot size is 3.6 x 7.2 inches. The limiting value of 2.5 is intended to get the entire plot on the 22 inch Versatec plotter without break. The plot will be 0.1 inches per degree, as specified by MIL-STD-850, or 18 x 36 inches.

NOTE: Subroutine CBMVSI must be modified to use a different plotter.

EXAMPLE: Enter any number from 0.1 to 2.5, followed by <CR>.

RESULT: The message "PLOTING" appears. Upon completion of the plotting, or storage for later plotting, the function ends.

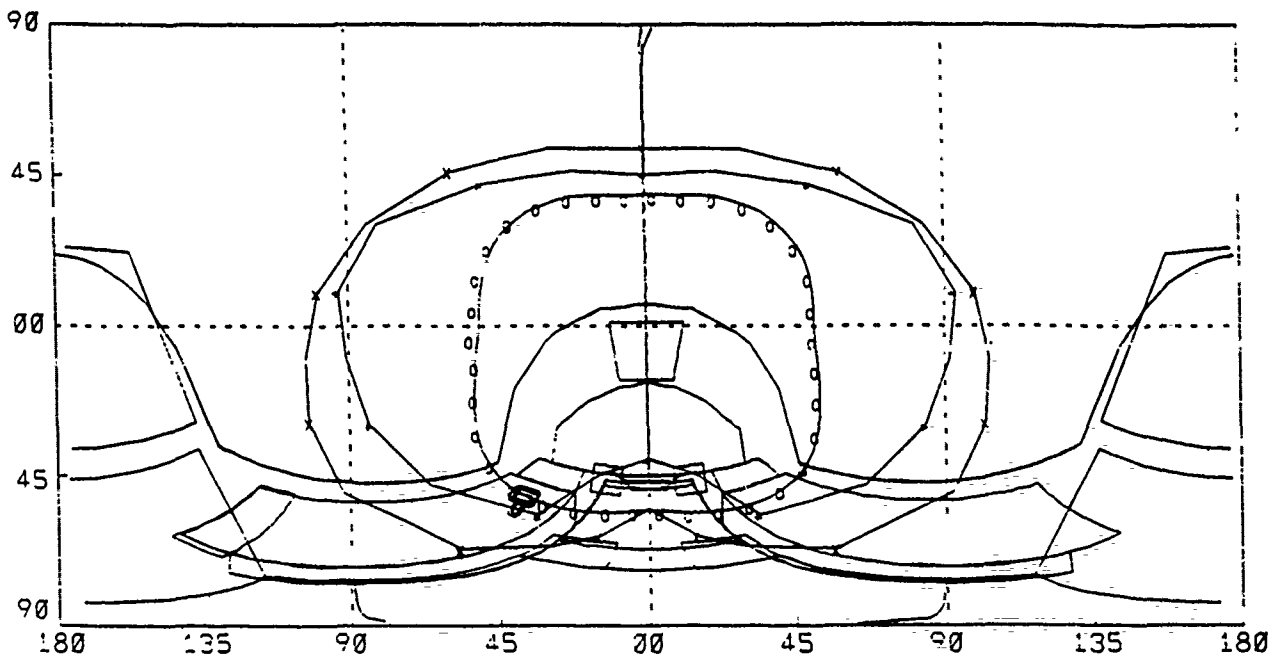
Figure 7. 39 shows a sample visibility plot for the A7E-01, with a man-model generated for the 50th percentile sitting

DEPRESS CR TO CONTINUE

VISIBILITY PLOT

SURVEY 267 USAF

CREWSTATION A7--SEAT



PLOT
DESCRIPTION
SCALE 1"=32'
X-AXIS
HORIZONTAL DEGREES
FROM LINE OF SIGHT
Y-AXIS
VERTICAL DEGREES
FROM LINE OF SIGHT

EYE POSITION IN SRP COOR	
1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	20
21	22
23	24
25	26
27	28
29	30
31	32
33	34
35	36
37	38
39	40
41	42
43	44
45	46
47	48
49	50
51	52
53	54
55	56
57	58
59	60
61	62
63	64
65	66
67	68
69	70
71	72
73	74
75	76
77	78
79	80
81	82
83	84
85	86
87	88
89	90
91	92
93	94
95	96
97	98
99	100

```
x= 3 41
y= 0 0
z= 31 85
```

HEAD IS POINTING

0° FROM VERTICAL
0° FROM HORIZONTAL

VISION LIMITS

X BASE LINE
O FIELD OF RESOLUTION
+ HGU-26 & MBU-5/P

Figure 7.39. Visibility Plot

height and weight from the R67USAF Survey, seated in a slumped posture and looking straight ahead.

Figure 7.40 is a sample of a cross reference listing, when State Switch 7 is set to "ON" prior to calling the Visibility Analysis function (PFK 6). The Cross Reference Listing lists the name of the panel, the locations of the panel vertices, in both horizontal and vertical line of sight angles and COMBIMAN coordinates. The horizontal and vertical line of sight for these vertices may be used to identify specific panels in the Visibility Plot (reference Figure 7.39), and thus determine if the panel, or portions of the panel, are within the vision field.

VISIBILITY MEMBER NAME: ATE-01

EYE LOCATION IN SRP SYSTEM (3.41, 0.0 , 31.86)

LINE-OF-SIGHT IN DEGREES (0, 0)

VISIBILITY PLOT DATA FOR CONTOUR: LMIPAN

LINE-OF-SIGHT ANGLES		COMBIMAN COORDINATES		
HORIZ.	VERT.	X	Y	Z
0	-46	26.111	0.0	-26.134
29	-41	26.111	14.750	-26.134
20	-31	27.766	14.750	-18.699
18	-23	29.060	9.570	-12.800
9	-18	29.702	4.500	-9.966
0	-17	29.710	0.0	-9.106

VISIBILITY PLOT DATA FOR CONTOUR: RMIPAN

LINE-OF-SIGHT ANGLES		COMBIMAN COORDINATES		
HORIZ.	VERT.	X	Y	Z
0	-46	26.111	0.0	-26.134
-29	-41	26.111	-14.750	-26.134
-20	-31	27.766	-14.750	-18.699
-18	-23	29.060	-9.570	-12.800
-9	-18	29.702	-4.500	-9.966
0	-17	29.710	0.0	-9.106

VISIBILITY PLOT DATA FOR CONTOUR: FWOHLCON

LINE-OF-SIGHT ANGLES		COMBIMAN COORDINATES		
HORIZ.	VERT.	X	Y	Z
22	-50	22.666	9.260	-29.164
40	-46	22.666	18.760	-29.164
36	-42	24.660	18.010	-27.382
33	-40	26.161	17.180	-26.146
20	-43	26.161	9.280	-26.146

VISIBILITY PLOT DATA FOR CONTOUR: LHCOM

LINE-OF-SIGHT ANGLES		COMBIMAN COORDINATES		
HORIZ.	VERT.	X	Y	Z
22	-60	22.424	9.260	-29.282
143	-62	-12.066	9.260	-28.982
110	-40	-12.066	23.010	-28.982
42	-44	22.423	20.000	-29.292

VISIBILITY PLOT DATA FOR CONTOUR: AFLHCOM

LINE-OF-SIGHT ANGLES		COMBIMAN COORDINATES		
HORIZ.	VERT.	X	Y	Z
130	-60	-7.016	8.600	-29.026
146	-63	-12.196	8.600	-28.980
117	-40	-12.196	23.620	-28.980
107	-60	-7.016	23.620	-29.036

Figure 7.40. Sample of Cross Reference Listing

7.5 RESET SLUMPED POSTURE FUNCTION (PFK 23)

The Reset Slumped Posture function resets the transformation angles of the man-model so that it assumes a Slumped Posture, as shown in Figure 7.41. The "Slumped Posture" is the default posture for the man-model sitting in a seat with a 13-degree back angle and a 6-degree seat pan angle. This function is commonly used to return to a starting posture after a reach analysis, or a modification of joint angles (Paragraph 3.2), results in a displayed posture other than the Slumped posture. The function may be called whenever the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 23 to reset to the Slumped Posture.

RESULT: The man-model is displayed in the Slumped posture (Figure 7.41) and the function terminates.

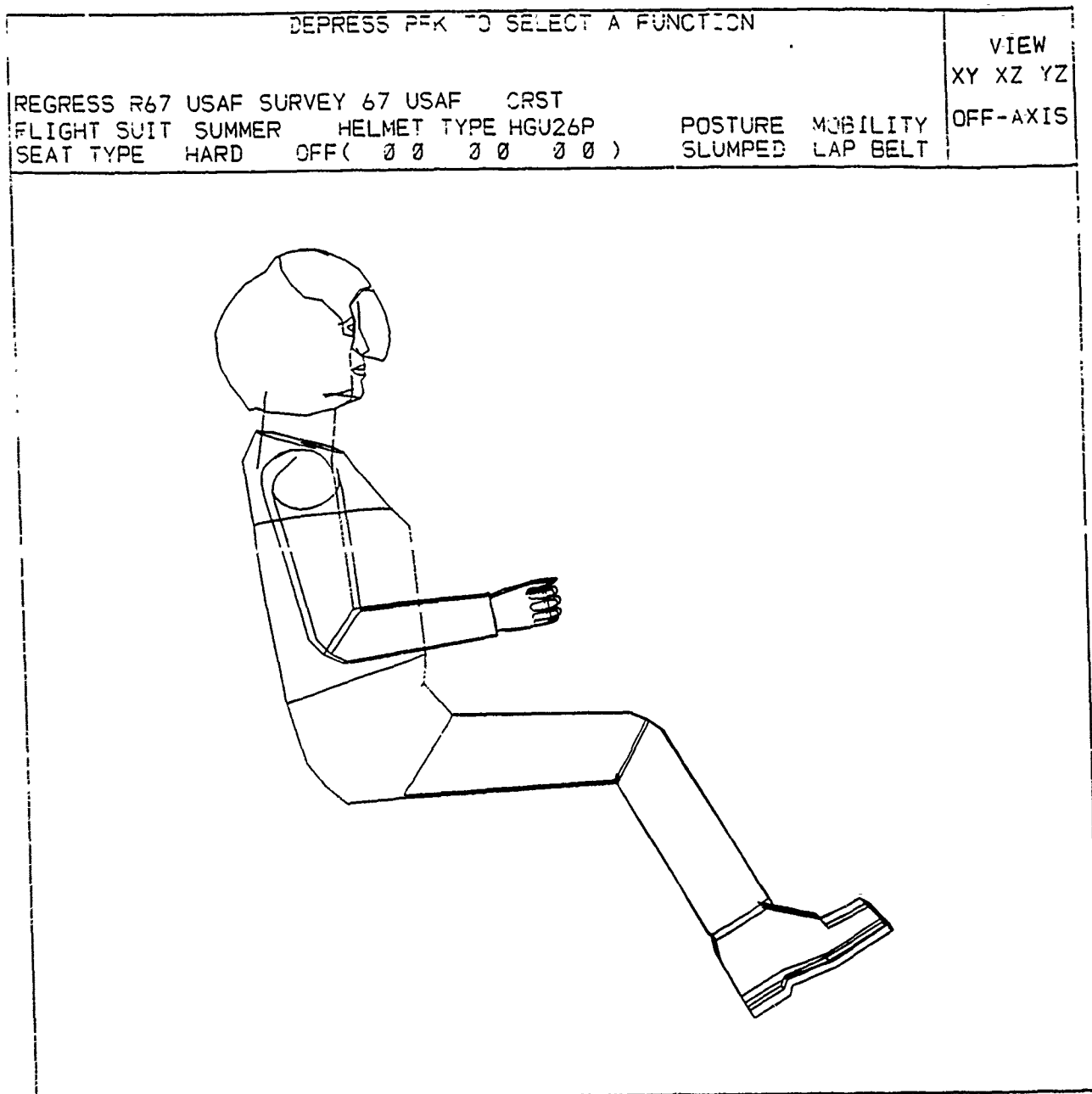


Figure 7.41. Reset Slumped Posture Function.

7.6 RESET ERECT POSTURE FUNCTION (PFK 24)

The Reset Erect Posture function resets the transformation angles of the man-model so that it assumes the standard Erect posture as shown in Figure 7.42. This is the standard posture for performing anthropometric measures on a seated subject, and is used to confirm dimensions of the man-model. The function may be called whenever the Function Selection prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 24 to reset posture to the Erect Posture.

RESULT: Man-model is displayed in the Erect posture and the function terminates.

DEPRESS PFK TO SELECT A FUNCTION

					VIEW	
					.XY XZ 'Z	
REGRESS R67	USAF SURVEY 67	USAF	CRST			
FLIGHT SUIT	SUMMER	HELMET TYPE	HGU26P	POSTURE	MOBILITY	OFF-AXIS
SEAT TYPE	-ARD	OFF(3 0	3 0 3 0)	EREC	LAP BELT	

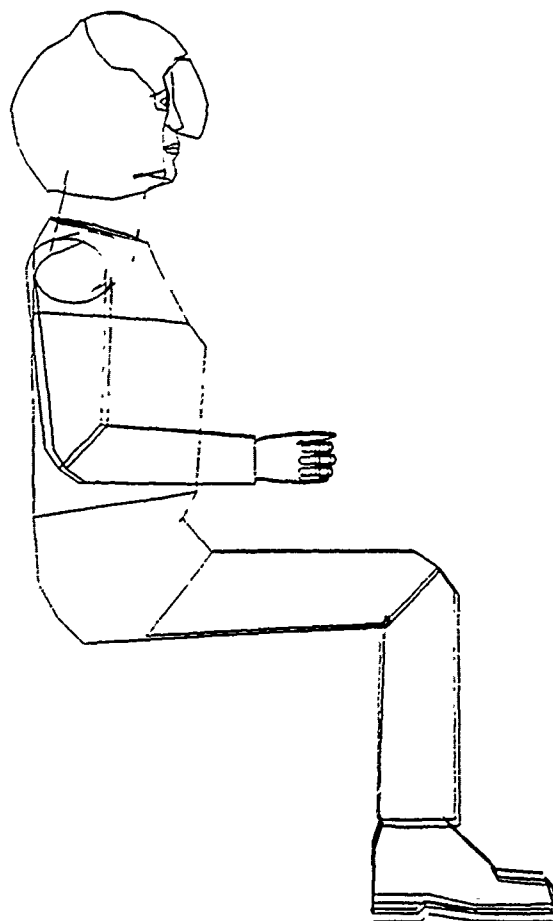


Figure 7.42. Reset Erect Posture Function.

7.7 RESET PROGRAMMED POSTURE FUNCTION (PFK 25)

The Reset Programmed Posture function resets the transformation angles of the man-model so that it assumes the "Programmed Posture." The "Programmed Posture" is any posture the user desires, which is achieved by modifying the transformation angles using the Display Link Table function (see Paragraph 3.2).

When the program CBM08 is initialized, the angles for the Slumped Posture are automatically entered into the Programmed Posture storage area, so initially pressing the PFK 25 merely recalls the Slumped Posture. However, when any one or more angles in the link system have been changed with the Display Link Table function, the changes are stored in the Programmed Posture storage area. This function displays the posture as reflected by the last change to the Link Table during the current program session or run. The angles changed by this function are not stored permanently. Therefore, every time a new man-model is defined with the Define Body Size function, the angles for Programmed Posture must be redefined if other than the Slumped Posture is desired. The function may be called whenever the Function Select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 25 to reset the posture to the Programmed Posture.

RESULT: The Programmed Posture currently stored in the program is displayed and the function terminates.

SECTION 8

PROGRAM-EXECUTION RELATED FUNCTIONS

Program-Execution Related functions are provided to set State Switches to select variations in the operation of the COMBIMAN program, and activate subfunctions which are infrequently used program functions. Additionally the program may be restarted or ended with function selections.

8.1 STATE SWITCH FUNCTION (PFK 29)

The State Switch function allows the user to select variations in the operation of the COMBIMAN program and to select subfunctions. When the COMBIMAN program is initiated all State Switch functions are set "OFF". The function may be selected at any time the function select prompt appears.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 29 to activate the State Switch function.

RESULT: The COMBIMAN display is replaced with the menu of available state switches and subfunctions (Figure 8.1). State Switch status may be changed, or subfunctions may be activated by selection.

8.1.1 Changing State Switch Status

The explanation of the function of each State Switch follows:

1. Crew Station Data

ON - Prints the three-dimensional coordinate data of the crew station geometry when the COMBIMAN program run is ended.

OFF - The three-dimensional coordinate data are not printed when the COMBIMAN program is ended.

SELECT STATE SWITCH NUMBER

#	STATUS	ON	OFF
1	OFF	PRINT CREWSTATION DATA	SUPPRESS CREWSTATION DATA
2	OFF	DISPLAY ALL LINKS OF MODEL	SUPPRESS ALL LINKS OF MODEL
3	OFF	DISPLAY NON-PERSPECTIVE MODEL	DISPLAY PERSPECTIVE MODEL
4	OFF	SUPPRESS ENFLESHMENT DISPLAY	DISPLAY ENFLESHED MAN-MODEL
5	OFF	SUPPRESS MAN-MODEL DISPLAY	DISPLAY MODEL & CREWSTATION
6	OFF	CHANGE VISIBILITY PLOT SCALE	ASSUME SCALE FACTOR 1 0
7	OFF	PRINT VISIBILITY DATA POINTS	SUPPRESS VISIBILITY DATA
8	OFF	ZOOMED IMAGE NOT RETAINED	RETAIN ZOOMED IMAGE
9	OFF	INPUT ANTH DATA FROM CARD	NO ANTH DATA FROM CARD
10	OFF	DISPLAY AIRCRAFT COORDINATES	DISPLAY COMBIMAN COORDINATE
11	OFF	PRINT LINK MATRICES	SUPPRESS LINK MATRICES

SELECT SUBFUNCTION

- 1 CONVERT CURRENT CREWSTATION COORDINATES TO ANOTHER COORDINATE SYSTEM
- 2 RESET ITERATIONS FOR RYP
- 3 CHANGE POINT OF VIEW AND/OR THE EFFECTIVE VIEWING DISTANCE

PRESS RETURN TO EXIT

Figure 8.1. State Switch and Subfunction Selection Menu

2. Man-Model Links

- ON** - The internal links of the man-model are displayed on the screen and are included in all plots.
- OFF** - Internal man-model links are not displayed or included in plots.

3. Perspective/Nonperspective View

- ON** - Displays a nonperspective view of the man-model and crew station.
- OFF** - Displays a perspective view of the man-model and crew station.

4. Enfleshment Display

- ON** - Suppresses the enfleshment display. The man-model will display the links only and appear as a stick figure.
- OFF** - The man-model is displayed with full enfleshment.

5. Man-model Display

- ON** - Suppresses the man-model display so that only the crew station is displayed or plotted.
- OFF** - The man-model, and crew station if retrieved, are displayed and plotted.

6. Visibility Plot Size

- ON** - When making hard copy plots the program accepts the input of a scale factor for the visibility plot.
- OFF** - Visibility plots are made at the default scale factor of 1.0, which produces a visibility plot with a scale of 0.04 inches per degree, or a plot size of 7.2 by 14.4 inches.

7. Print Visibility Data

- ON** - Prints a cross-reference listing of the line-of-sight angles for the crew station panels. The three-dimensional coordinate data for panels are printed in COMBIMAN and user defined coordinates.
- OFF** - Visibility data are not printed.

8. Reset After Zoom

- ON** - Upon ending the Zoom function, the display is reset from the magnified image to the normal scale.
- OFF** - Upon ending the Zoom function, the magnified image is retained until (1) the body size is redefined (PFK 4), or, (2) the program is restarted (PFK 30).

9. Read Anthropometric Data from Cards

- ON** - Enables the input of the 12 anthropometric dimensions of Option 2, PFK 4, from a card data format file.
- OFF** - The values for the 12 anthropometric values must be entered on the ANKB.

10. Change Coordinate System

- ON** - The panel coordinate system is displayed in the user defined coordinate system.
- OFF** - Panel coordinate data are displayed in the COMBIMAN coordinate system.

11. Print Link Matrices

- ON** - Prints the transformation equations and matrix elements for all of the internal man-model links every time the man-model is displayed.

NOTE: When State Switch 11 is set "ON", approximately 470 lines (7 - 9 pages) are printed for each posture change. If there are several posture changes, the printout will consume significant printer resources, so use only when needed.

- OFF** - Link data will not be printed.

PROMPT: SELECT STATE SWITCH NUMBER (Upper prompt)

ACTION: The selection of a State Switch number acts as a toggle switch, changing the ON/OFF status of the state switch.

EXAMPLE: Select State Switch 5

RESULT: The flag in the status column changes to ON.
The status of other state switches may be changed

by making the proper selection. When all desired changes have been made proceed to the bottom prompt.

PROMPT: PRESS RETURN TO EXIT (Bottom prompt)

ACTION: Press <CR>

RESULT: The function select prompt appears, and the screen displays the previously retrieved crew station without the man-model.

8.1.2 Selecting Subfunctions

Subfunctions are functions of the COMBIMAN program which are infrequently used. Unlike state switches, they require further input from the user. They are activated by selecting the subfunction number from the menu in Figure 8.1.

PROMPT: SELECT SUBFUNCTION (Middle prompt)

ACTION: Select the number for the desired subfunction.

RESULT: The subfunction is activated. Since the two subfunctions available in this version of COMBIMAN are completely different, each will be explained in detail in following paragraphs.

8.1.2.1 Subfunction 1. Convert Crew Station Coordinates to Another Coordinate System

In developing a Crew Station data base member, the user must define the positive directions of the coordinate axes and the coordinates of the Seat Reference Point (SRP). This subfunction is provided to change the coordinate axes directions and the SRP coordinates. In specific instances it might be advantageous for the user to work in a local coordinate system while

modifying a crew station or making an analysis, and this subfunction can be used to accomplish such temporary changes.

PROMPT: SELECT SUBFUNCTION (Middle prompt)

ACTION: Select Subfunction 1

RESULT: The subfunction is activated and the first menu appears. The Seat Reference Point coordinates and positive directions of the X, Y and Z axes of the existing user defined coordinate system are displayed. There are three prompts at the bottom of the display.

PROMPT: IF SEAT REFERENCE POINT IS INCORRECT SELECT (CHANGE SRP)
IF AXES DIRECTIONS ARE WRONG SELECT (CHANGE DIRECTIONS)
IF SRP AND AXES ARE CORRECT SELECT (EXECUTE)

ACTION: Select one of the three choices.

- (*CHANGE SRP*)

OR:

- (*CHANGE DIRECTIONS*)

OR:

- (*EXECUTE*)

EXAMPLE 1: Select (*CHANGE SRP*) (Reference Paragraph B.3.1)

RESULT: The bottom prompt changes as in Figure 8.2.

PROMPT: ENTER X COORDINATE POINT FOLLOWED BY RETURN

ACTION: Enter the X coordinate value of the seat reference point in the new user defined coordinate system.

EXAMPLE: Enter 277.17, followed by <CR>.

RESULT: The value entered appears under the X column and the next prompt appears.

PROMPT: ENTER Y COORDINATE POINT FOLLOWED BY RETURN

CHANGE CREW STATION COORDINATE SYSTEM

SEAT REFERENCE POINT

X Y Z
_ (, ,)

DIRECTION OF AXES

ORIGINAL AXES

DIRECTION OF POSITIVE X AXIS	-	FORWARD	:
DIRECTION OF POSITIVE Y AXIS	-	LEFT	.
DIRECTION OF POSITIVE Z AXIS	-	UP	

ENTER X COORDINATE POINT FOLLOWED BY RETURN

Figure 8.2. Enter X Coordinate Point

ACTION: Enter the Y coordinate value of the seat reference point in the new user defined coordinate system.

EXAMPLE: Enter 0.01, followed by <CR>.

RESULT: The value entered appears under the Y column and the next prompt appears.

PROMPT: ENTER Z COORDINATE POINT FOLLOWED BY RETURN

ACTION: Enter the Z coordinate value of the seat reference point in the new user defined coordinate system.

EXAMPLE: Enter 95.35, followed by <CR>.

RESULT: The value entered appears under the Z column and the screen reverts to the display shown in Figure 8.1.

EXAMPLE 2: Select(*CHANGE DIRECTIONS*) (Reference Paragraph B.3.1)

RESULT: Screen displays a SELECT indicator to the left of the "DIRECTION OF POSITIVE X AXIS" line, with the possible directions listed (Figure 8.3). The original axis direction is still listed under the "ORIGINAL AXIS" column.

PROMPT: SELECT DIRECTION OF X AXIS

ACTION: Select one of the six listed directions.

EXAMPLE: Select AFT

RESULT: The direction selected appears to the right of the "DIRECTION OF POSITIVE X AXIS" line. The set of associated directions (FORWARD and AFT) is erased and the SELECT indicator moves to the next line.

PROMPT: SELECT DIRECTION OF Y AXIS

ACTION: Select one of the four possible directions listed.

EXAMPLE: Select RIGHT

RESULT: The direction selected appears to the right of "DIRECTION OF POSITIVE Y AXIS" line. The associated directions (RIGHT and LEFT) are

CHANGE CREW STATION

COORDINATE SYSTEM

SEAT REFERENCE POINT

X	Y	Z
(277 17	, 0 01	, 95 35)

DIRECTION OF AXES

ORIGINAL AXES

SELECT DIRECTION OF POSITIVE X AXIS	-	FORWARD
DIRECTION OF POSITIVE Y AXIS	-	LEFT
DIRECTION OF POSITIVE Z AXIS	-	UP

---POSSIBLE DIRECTIONS---

FORWARD	LEFT	UP
AFT	RIGHT	DOWN

SELECT DIRECTION OF X AXIS

Figure 8.3. Select Direction of X Axis

erased and the SELECT indicator moves to the next line.

PROMPT: SELECT DIRECTION OF Z AXIS

ACTION: Select one of the two possible directions listed.

EXAMPLE: Select UP.

RESULT: The direction selected appears to the right of the "DIRECTION OF POSITIVE Z AXIS" line. The screen displays the changed seat reference point coordinate values and positive axes directions (Figure 8.4).

EXAMPLE 3: Select (*EXECUTE*)

RESULT: The subfunction executes. The new user defined coordinate system is not written to the Crew Station data base, but is retained in the program for the remainder of the run, or until changed again. Since the data is not written to the Crew Station data base, those functions of the program which derive data from the Crew Station data base will not recognize the changed coordinate system. For example, print outs of Visibility Analysis and Reach Analysis data will be in the coordinate system stored in the data base. Permanent changes to the user defined coordinate system must be made with the use of PFK 10, (Save Current Crew Station), or with the procedures outlined in Appendix B.

8.1.2.2 Subfunction 2. Reset Iterations for RYP.

This subfunction is provided so the user may change the Roll, Pitch and Yaw angles and/or the number of keystroke increments for the Increment Roll, Pitch and Yaw function (PFK 26).

PROMPT: SELECT SUBFUNCTION (Middle prompt)

ACTION: Select Subfunction 2

RESULT: Display changes and the next prompt appears.

CHANGE CREW STATION

COORDINATE SYSTEM

SEAT REFERENCE POINT

X	Y	Z
(277 17	, 0 01	, 95 35)

DIRECTION OF AXES

ORIGINAL AXES

DIRECTION OF POSITIVE X AXIS	- AFT	FORWARD
DIRECTION OF POSITIVE Y AXIS	- RIGHT	LEFT
DIRECTION OF POSITIVE Z AXIS	- UP	UP

(*CHANGE SRP*) (*CHANGE DIRECTIONS*) (*EXECUTE*)

IF SEAT REFERENCE POINT IS INCORRECT SELECT (CHANGE SRP)
IF AXES DIRECTIONS ARE WRONG SELECT (CHANGE DIRECTIONS)
IF SRP AND AXES ARE CORRECT SELECT (EXECUTE)

Figure 8.4. Changed Seat Reference Point Coordinates and Positive Axes Directions

PROMPT: ENTER ROLL ANGLE

ACTION: Enter the desired Roll angle value for rotation around the X axis (negative = left, positive = right) on the ANKB.

EXAMPLE: Enter - 30, followed by <CR>.

RESULT: Next prompt appears.

PROMPT: ENTER PITCH ANGLE

ACTION: Enter the desired Pitch angle value for rotation around the Y axis (negative = nose up, positive = nose down) on the ANKB.

EXAMPLE: Enter 10, followed by <CR>.

RESULT: Next prompt appears.

PROMPT: ENTER YAW ANGLE

ACTION: Enter the desired Yaw angle value for rotation around the Z axis (negative = right, positive = left) on the ANKB.

EXAMPLE: Enter - 25, followed by <CR>.

RESULT: Next prompt appears.

PROMPT: ENTER MAX. NO. OF ITERATIONS

ACTION: Enter the number of keystrokes PFK 26 (Increment Roll, Pitch and Yaw function) should make before resetting the display to the XZ (side) view.

EXAMPLE: Enter 5, followed by <CR>.

RESULT: Display returns to the State Switch/Subfunction Select menu (see Figure 8.1).

PROMPT: PRESS RETURN TO EXIT (Bottom prompt)

ACTION: When Roll, Pitch and Yaw angles and/or number of iterations are set to desired values, press <CR> to exit the function.

RESULT: Screen returns to the display mode with the function select prompt in the prompting area.

8.2.3. Subfunction 3. Change Point of View and/or Effective
Viewing Distance

This subfunction is not operable in this version of
COMBIMAN.

8.2 RESTART PROGRAM FUNCTION (PFK 30)

The Restart Program function allows the user to restart program CBM08 whenever the function select prompt appears. When this function is activated all state switches, anthropometric dimensions and crew station data are reset to default values. Any modifications made to link lengths, link angles or crew station definitions before depressing PFK 30 are lost.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress **PFK 30** to activate the Restart Program function.

RESULT: The next prompt appears.

PROMPT: SELECT RESTART OR NO RESTART BELOW
 RESTART NO RESTART

ACTION: Select one of the two choices.

- Select RESTART to return the program to its starting point.

OR:

- select NO RESTART to the screen display shown prior to selecting PFK 30, with the function select prompt in the prompting area.

EXAMPLE: Select **RESTART**

RESULT: Program momentarily displays the COMBIMAN banner and then the first menu selection for the Define Body Size function (PFK 4).

8.3 END PROGRAM FUNCTION (PFK 31)

The END PROGRAM function is provided to allow the user to end the program whenever the function select prompt is present.

PROMPT: DEPRESS PFK TO SELECT A FUNCTION

ACTION: Depress PFK 31 to activate the End Program function.

RESULT: The next prompt appears.

PROMPT: SELECT END COMBIMAN OR DO NOT END BELOW
 END COMBIMAN DO NOT END

ACTION: This is a safety to prevent ending the program if PFK 31 is accidentally depressed.

- Select END COMBIMAN if you intended to end the program.

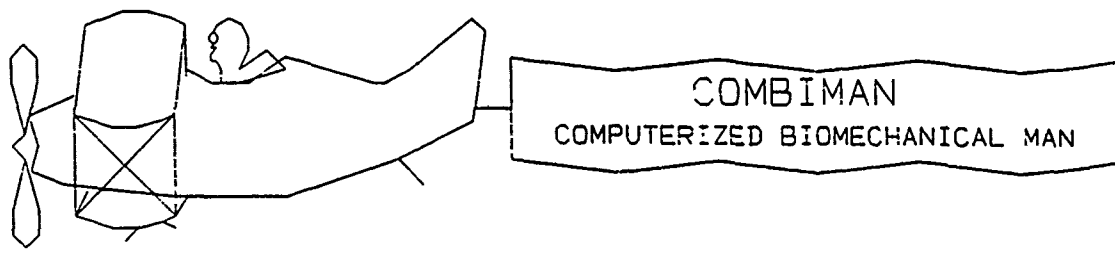
OR:

- Select DO NOT END if you did not intend to end the program, and desire to return to the program at the point prior to depressing PFK 31.

EXAMPLE: Select END COMBIMAN

RESULT: The COMBIMAN banner is displayed (Figure 8.5) and the program is terminated. Data and messages are printed.

THE END



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Figure 8.5. End of the COMBIMAN Program Banner

SECTION 9

PROGRAM MESSAGES - INFORMATION AND ERROR TYPES

The program CBM08 prints out both information and action oriented messages. The message format is as follows:

CBM0nni Message Text

where:

CBM	identifies the message and indicates that the message originates from the COMBIMAN system,
0	identifies the message and indicates that the message originates from the program CBM08,
<u>nn</u>	is the message number,
<u>i</u>	is the action code (I=information, A=action to be performed), and
<u>message text</u>	is the message text.

The messages are as follows:

CBM001I COMBIMAN V8, DATE=MM/DD/YY, TIME=hh.mm.ss
Issued By: CBMINT
Reason: Program CBM08 started at this date and time.
System Action: Execution continues.
User Action: None.

CBM002I PROGRAM END
Issued By: CBMRTS
Reason: The user requested the END PROGRAM function.
System Action: The program ended as requested.
User Action: None.

CBM003I PROGRAM RESTART
Issued By: CBMRTS
Reason: The user requested the RESTART PROGRAM function.

System Action: The program restarted as requested.
User Action: None.

CBM007I Panel number. PANEL NAME: panel number, TYPE=nn, nn.
VERTICES

Issued By: CBMPNL or CBMCRW

Reason: The user defined a panel through the
DESIGN PANEL function.

or

The user requested the crew station data
by setting state switch 1 "ON".

System Action: The defined panel is accepted or the crew
station data are printed.

User Action: None.

CBM009I SWITCH switchnumber ON/OFF

Issued By: CBMSSW

Reason: The user requested a change in the
execution of the program using the STATE
SWITCH function.

System Action: Switch switchnumber is now either "ON" or
"OFF".

User Action: None.

CBM010I IDENTIFIED panelname

Issued By: CBMI0I

Reason: The user requested the IDENTIFY PANEL
function to identify an object displayed
on the screen.

System Action: The system displays the name of the
panel, the coordinates of the panel
center of gravity and the internal "key"
number.

User Action: None.

CBM011I OMITTED panelname

Issued By: CBMI0I

Reason: The user requested that a panel be
removed from the display using the "OMIT
PANEL" function.

System Action: The light-penned panel is removed from
the screen.

User Action: None.

CBM012I INCLUDED panelname

Issued By: CBMIOI

Reason: The user requested that a panel be included back into the display using the INCLUDE PANEL function.

System Action: The requested panel is included back into the display.

User Action: None.

CBM014I CREW STATION DATA FROM membername

Issued By: CBMCRW

Reason: The user requested the retrieval of a crew station definition by the RETRIEVE CREW STATION function.

System Action: The requested crew station member is retrieved.

User Action: None.

CBM015I SURVEY DATA FROM membername

Issued By: CBMINI

Reason: The user requested membername Survey Data from the Anthropometric Data Base.

System Action: The requested survey data are retrieved.

User Action: None.

CBM016I VIEW=(roll, pitch, yaw), SCALE=factor, OFFSET=(x,y,z)

Issued By: CBMVCW

Reason: The user requested a new off-axis view through the "CHANGE VIEW" function.

System Action: The display is rotated as specified.

User Action: None.

CBM018I INITIALIZATION DATA MISSING

Issued By: CBMINT

Reason: Initialization Data could not be found.

System Action: The program is terminated.

User Action: Check to see that initialization data set has not been destroyed.

CBM019I PLOTS COMPLETED

Issued By: CBMCP1

Reason: The requested hard copy plot of the COMBIMAN display is finished.

System Action: Continue processing.

User Action: None.

CBM022A TOO MANY PANELS/VERTICES

Issued By: CBMCRW

Reason: More panels were defined through the RETRIEVE CREW STATION function (PFK5) or the DESIGN PANEL function (PFK16) than could be handled at one time. The maximum number of panels that can be handled at one time is 300.

System Action: The panel being defined is ignored.

User Action: Delete a few panels by the DELETE PANEL function (PFK18) or delete a crew station using the RETRIEVE CREW STATION function before defining more panels.

CBM026I DELETE PANEL panelname

Issued By: CBMDPL

Reason: The user requested to delete panel panelname using the DELETE PANEL function.

System Action: The panel is deleted.

User Action: None.

CBM031A CREW STATION DATABASE MISSING

Issued By: CBMCRW

Reason: Identification record of the file containing a crew station data is missing.

System Action: Displays similar message to CRT and returns control to main program.

User Action: Stop program, if crew stations are needed.

CBM033I REGRESSION VALUES FROM MEMBER membername

Issued By: CBMIN1

Reason: User entered a valid regression type 0 anthropometric data base membername using light-pen.

System Action: Data from the referenced member are read.

User Action: None.

CBM034A ANTHROPOMETRIC DATA BASE MISSING.

Issued By: CBMINT, CBMIN1

Reason: The identification record of the file which contains anthropometric data is missing.

System Action: Displays similar message on CRT and returns control to main program.

User Action: Stop program; create Anthropometric Data Base.

CBM035A VARIABLE NO. nn OF REGRESSION SURVEY membername HAS
 INVALID UNIT OF uu
 Issued By: CBMIN1
 Reason: The unit of measurement read in for the
 specified variable and survey was not
 either IN, CM, MM, LB, or KG.
 System Action: Remainder of data for variable is read
 in.
 User Action: Report condition to systems programmer.

CBM039I UNIT OF VARIABLE vblname HAS BEEN CHANGED TO uu
 Issued By: CBMIND, CBMDEP
 Reason: The user changed the default unit of
 measurement of the selected variable.
 System Action: Flag the unit as being changed.
 User Action: None.

CBM040A INVALID UNIT OF uu SPECIFIED FOR VARIABLE vblname
 Issued By: CBMIND, CBMDEP
 Reason: The variable in question was defined in
 the anthropometric survey as having a length
 or weight type of measurement. The unit
 specified by the user was not consistent
 with the original definition.
 System Action: Change ignored.
 User Action: Specify correct unit or keep default
 unit.

CBM041I INPUT VARIABLES WILL BE IN PERCENTILES
 Issued By: CBMIND, CBMDEP
 Reason: User had indicated that values for
 anthropometric variables will be given as
 percentiles.
 System Action: None.
 User Action: None.

CBM042I INPUT VARIABLES WILL BE IN ABSOLUTE VALUES
 Issued By: CBMIND, CBMDEP
 Reason: User has indicated that values for
 variables will be given in engineering
 units.
 System Action: None.
 User Action: None.

CBM043I USER CHOOSES TO INPUT nn DEPENDENT VARIABLES
 Issued By: CBMLEP
 Reason: User has depressed OPT 2, indicating the
 decision to enter values for all the
 dependent anthropometric variables.

System Action: None.
User Action: None.

CBM044I STANDARD ERROR MULTIPLICATION FACTOR RESET TO nnn.nn
Issued By: CBMIND
Reason: User has entered a new value for standard error of estimate.
System Action: Value changed internally.
User Action: None.

CBM045I USER CHOOSES TO INPUT 2 INDEPENDENT VARIABLES
Issued By: CBMIND
Reason: User has depressed OPT 1, indicating the decision to enter values for two independent anthropometric variables.
System Action: None.
User Action: None.

CBM046A ANTHROPOMETRIC DIMENSION vb1name REFERENCED BY LINK link name DOES NOT EXIST IN MEMBER membername
Issued By: CBMIN1
Reason: One of the vital anthropometric dimensions needed to generate the link length in question does not exist in the referenced survey member.
System Action: Program ends.
User Action: Print contents of referenced member from Anthropometric Data Base, using PRT function of CBMAM.

CBM047A ABNORMAL PROGRAM END
Issued By: CBMIN1
Reason: Key data vital to the construction of the man-model were not available.
System Action: Program ends.
User Action: Contact systems programmer.

CBM048I DATA WRITTEN FOR OFF-LINE PLOT NO. nn
Issued By: CBMCP1
Reason: Coordinate and index data for man-model and crew station configuration have been written onto disk file specified by FT11F001 DD card. nn. is the plot number.
System Action: None.
User Action: None.

CBM049A I/O ERROR ON UNIT 11. OFF-LINE PLOT DATA nn NOT SAVED

Issued By: CBMCP1

Reason: Input-output error on file where coordinate data are written. Plot data for plot nn are not saved.

System Action: Return to calling program.

User Action: None.

CBM052I VISIBILITY PLOT GENERATED FOR visibility member

Issued By: CBMVIS

Reason: Successful completion of visibility plot.

System Action: None.

User Action: None.

CBM053A NUMBER OF COMBINATIONS OF INDEPENDENT VARIABLES SUPPLIED BY MEMBER survey name DOES NOT EQUAL THAT SUPPLIED BY MEMBER regression name

Issued By: CBMIN1

Reason: Values for number of independent combinations are different from number supplied by regression member.

System Action: Values supplied by regression member are used.

User Action: Contact systems programmer.

CBM054A NUMBER OF DEPENDENT VARIABLES SUPPLIED BY MEMBER survey name DOES NOT EQUAL THAT SUPPLIED BY MEMBER regression name

Issued By: CBMIN1

Reason: Values for number of dependent variables are different from number supplied.

System Action: Values supplied by regression member are used.

User Action: Contact systems programmer.

CBM055I UNIT 9 NOT A VISION LIMIT OVERLAY DATA BASE

Issued By: CBMVIS

Reason: Identification record of Vision Limit Overlay is missing.

System Action: Terminates Visibility Analysis Function.

User Action: Stop program if Visibility Plot is needed.

CBM058I END OF DATA ON UNIT 9

Issued By: CBMVIS

Reason: Insufficient data on Unit 9 to generate vision overlay plot.

System Action: Return to calling program.

User Action: Contact systems programmer.

REFERENCES

1. Churchill, E., Kitka, P. and Churchill, T., October 1977 The Aerospace Medical Research Laboratory Anthropometric Data Bank Library, Volumes I to V, AMRL-TR-77-1, Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
2. Churchill, E., McConville, J., Laubach, L. and White, R., December 1971, Anthropometry of US Army Aviators - 1970, TR-72-52-CE, Clothing And Personal Life Support Equipment Laboratory, U.S. Army Natick Laboratories, Natick, Massachusetts.
3. Clauser, C., Tucker, P., McConville, J., Churchill, E., Laubach, L. and Reardon, J., April 1972, Anthropometry of Air Force Women, AMRL-TR-70-5, Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
4. Gifford, E., Provost, J. and Lazo, J., 1965, Anthropometry of Naval Aviators - 1964, NAEC-ACEL 533, U.S. Naval Air Engineering Center, Philadelphia, Pennsylvania.
5. Grunhofer, H. and Kroh, G., 1975, A Review of German Air Force and United States Air Force Personnel 1967-1968, AGARD-AG-205, North Atlantic Treaty Organization, Advisory Group for Research and Development, 7 Rue Ancelle, 92200 Neuilly sur Seine, France.
6. IBM System/360 Operating System Graphic Subroutine Package (GSP) for Fortran IV, COBOL, and PL/I, July 1969, Program Number 360S-IM-537. File No. 5360-24, -25, -29 (GC27-6932-3), IBM Corporation, Programming Publications, Dept. 637, Neighborhood Road, Kingston, New York.

BIBLIOGRAPHY

1. Bapu, P., Evans, S., Kitka, P., and McDaniel J., January 1981, User's Guide for the COMBIMAN Programs, Version 4, AFAMRL-TR-80-91, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
2. Bapu, P., Kitka, P., Korna, M. and McDaniel, J., April 1982, User's Guide for COMBIMAN Programs, Version 5, AFAMRL-TR-81-151, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
3. Bapu, P., Korna, M. and McDaniel, J., December 1983, User's Guide for COMBIMAN Programs, Version 6, AFAMRL-TR-83-097, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
4. Bates, F.J., Evans, S.M., Krause, H.E. and Luming, H., 1974, Three Dimensional Display of the COMBIMAN Man-Model and Workspace, AMRL-TR-74-15, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
5. Boydstun, L.E. and Kessel, D.S., March 1980, Maximum Reach Models for the Seated Pilot, Center for Ergonomics, College of Engineering, The University of Michigan, Ann Arbor, Michigan.
6. Churchill, E., Churchill, T. and Kitka, P., May 1978, Intercorrelations of Anthropometric Measurements: A Source Book for USA Data. AMRL-TR-77-2, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
7. Evans, S.M., May 1978, Updated User's Guide for the COMBIMAN Programs, AMRL-TR-78-31, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.
8. Korna, M. and McDaniel, J., User's Guide for the COMBIMAN Programs, Version 7, AFAMRL-TR-85-057, Air Force Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio.

9. Miller, K.L., March 1983, Determination of a Maximum Reach Envelope Using Spherical Harmonics, UDR-TR-83-27, University of Dayton Research Institute, University of Dayton, Dayton, Ohio.

APPENDIX A

COMBIMAN ANTHROPOMETRY

Anthropometry as used in the context of the COMBIMAN system of programs has several aspects. Included are a skeletal link system, joint mobility of the link system, enfleshment of the man-model, available strength, anthropometric surveys and an anthropometric data base maintenance program (CBMAM).

A.1 COMBIMAN LINK SYSTEM

The COMBIMAN man-model is based on a 35 link skeletal system, with links connecting major points of rotation as shown in Figure A.1. Link segment lengths, which together make up the link lengths, are generally internal dimensions which are difficult to measure on live subjects. To overcome this difficulty, 12 readily measurable anthropometric surface dimensions (Table A.1) are used for generating the COMBIMAN link system.

The program requires values for all 12 of these anthropometric variables to generate the 35 internal link lengths. These are taken from the on-line Anthropometric Data Base Survey Member, or from data supplied by the user in card image format. There are options available for providing the values for the 12 variables, which are discussed in Section 3 of this user's guide.

The program uses the link data and other data from external files to develop the man-model display. These stages of development are not visible to the user, and the completed man-model is displayed on the CRT (Figure A.2).

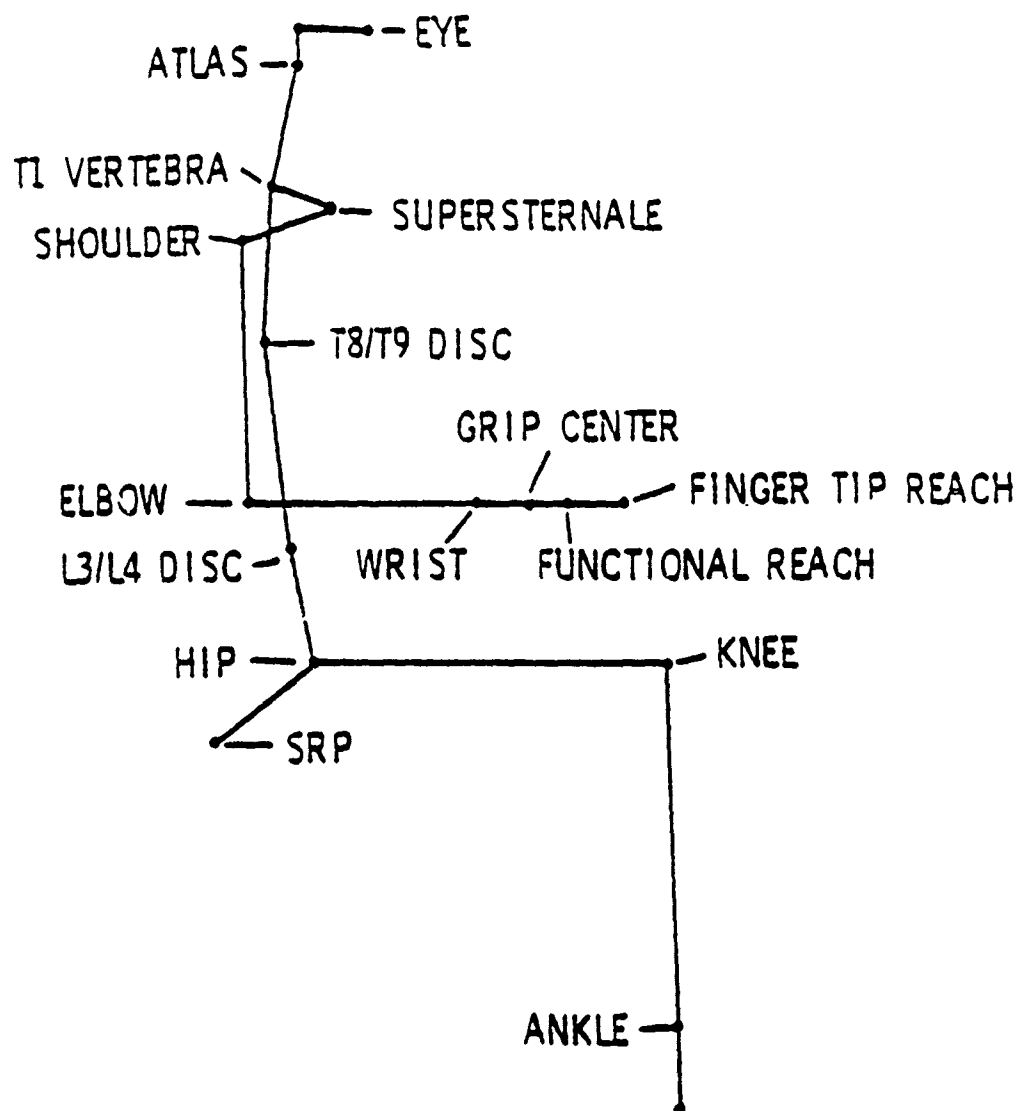


Figure A.1. COMBIMAN Link System - Side View.

TABLE A.1

LIST OF DEPENDENT VARIABLES NEEDED TO GENERATE
COMBIMAN LINK SYSTEM

Name	16 Character Abbreviation (If Applicable)
1. Weight	
2. Sitting Height	
3. Acromion Height, Sitting	(ACROMION HGT/SIT)
4. Knee Height, Sitting	(KNEE/HGT/SITTING)
5. Buttock-Knee Length	(BUTTOCK-KNE LGTH)
6. Shoulder Elbow Length	(SHOULDER-ELB LGTH)
7. Biacromial Breadth	(BIACROMIAL BRDTH)
8. Hip Breadth	
9. Chest Depth	
10. Foot Length	
11. Hand Length	
12. Elbow-Wrist Length	(ELBOW-WRIST LGTH)

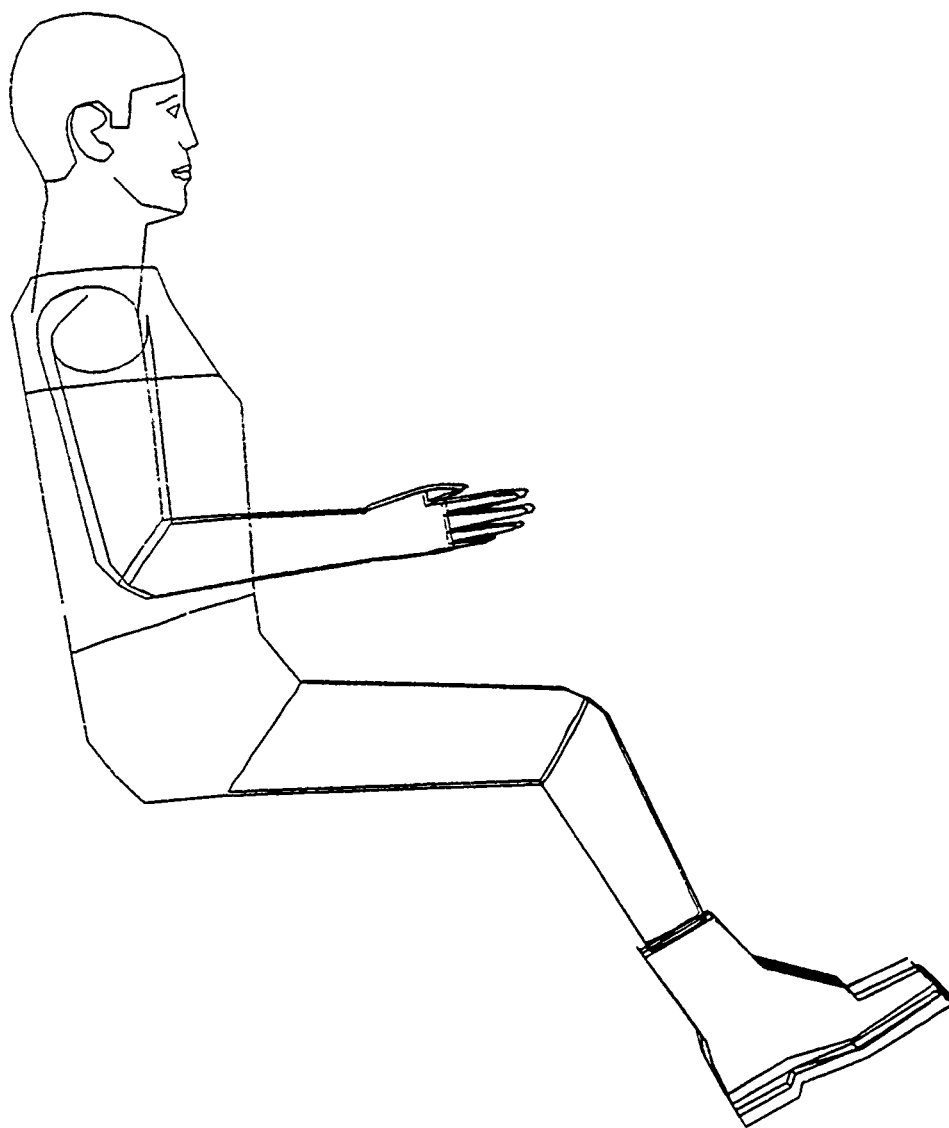


Figure A.2. Enfleshed COMBIMAN as it Appears on the CRT.

A.2 JOINT MOBILITY LIMITS

Joint mobility data supplied by the Armstrong Aerospace Medical Research Laboratory were used to construct mobility equations involving the Euler transformation variables (ϕ), (θ) and (ψ) for the COMBIMAN system of programs. The mobility limits are used to place realistic limits on man-model movement when using the analysis functions (Reach, Reach Curve and Strength) which automatically reposition the man-model body and body segments. The joint mobility limits are modified by the application of constraint factors caused by the bulk of programmed clothing types and mobility restraints such as lap belts and shoulder harnesses. The equations are internal to the program and cannot be changed by the user.

A.3 COMBIMAN ENFLESHMENT

Enfleshment is added to the skeletal link system. Early versions added enfleshment ellipsoids around the link joints and then connected the ellipsoids with tangent lines to define the contour of the model (Figure A.3). The radii of enfleshment ellipsoids are based upon data from anthropometric surveys in the AAMRL Anthropometric Data Bank. The general outline of the man-model was depicted on the screen by a series of dots and line segments.

As the development of COMBIMAN proceeded through several versions, programmers and users recognized a need for a more life-like simulation of a fully dressed pilot to be displayed on the screen. A series of programs were developed to generate a

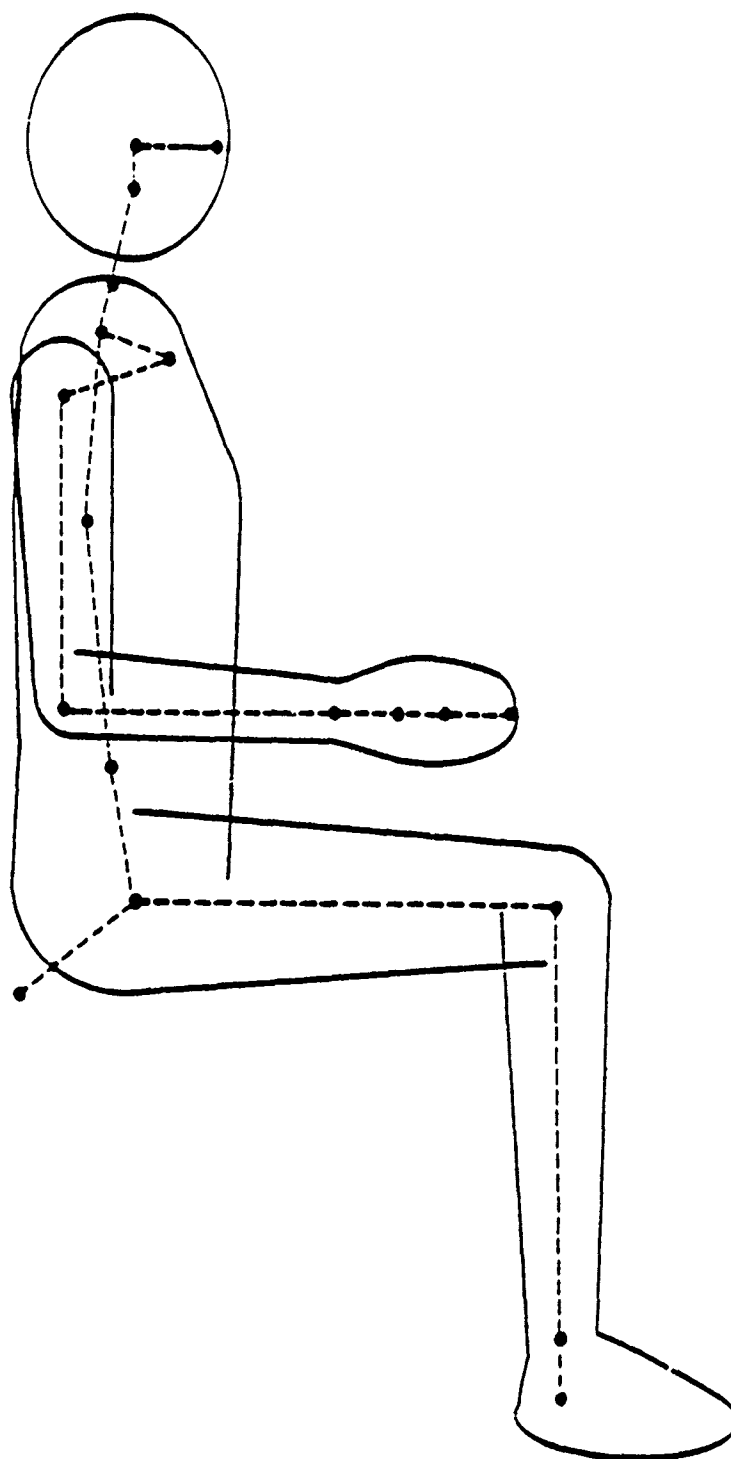


Figure A.3. Early COMBIMAN Enfleshment.

fully enflashed man-model complete with helmet, hands, boots and clothing.

There are 7 clothing configurations in COMBIMAN

1. SEMICLAD
The semiclad configuration is used as the base line for establishing the bulk of other clothing configurations.
2. SUMMER SUIT
The man-model is displayed with the bulk of the summer flying suit.
3. SUMMER SUIT W/VEST
The man-model is displayed with the bulk of the summer suit and survival vest.
4. WINTER SUIT
The man-model is displayed with the bulk of the winter flying suit.
5. WINTER SUIT W/VEST
The man-model is displayed with the bulk of the winter flying suit and survival vest.
6. WINTER SUIT W/VEST JACKET AND LIFE PRESERVER
The man-model is displayed with the bulk of the winter flying suit, survival vest, jacket and life preserver.
7. CHEMICAL DEFENSE
The man-model is displayed with the bulk of the chemical defense clothing ensemble.

For each clothing configuration the program internally limits the joint range mobility to account for encumbrances of the bulk of the clothing configuration.

The key to a more life-like simulation was the development of a technique to define three-dimensional coordinates of solid objects. A solid object, such as a helmet, boot or head form, is divided into triangular facets, with the vertices and edges of the triangle identified. A sonic digitizer is used to define the local X,Y and Z coordinates of the triangle vertices. A series

of sorting routines to: identify coincidental edges and points; convert the X,Y,Z local coordinates to the COMBIMAN coordinate system; and, determine display lines; are used to provide the desired graphic presentation.

The design for the enfleshment relies primarily on placing ellipses about major joint centers, connecting these ellipses and using the modeling technique for solid objects to determine display lines. Multiple ellipses exist at joint centers such as the knees, elbows and shoulders which exhibit high compressibility. The body itself is divided into 13 semi-unique sets of ellipses. These are lower and upper trunk, head, lower and upper arms, hands, and lower and upper legs. The lower legs include the feet. These sets are classified as semi-unique as a main ellipse can be contained in more than one set. For example, the lower and upper arm sets each contain the main ellipse at the elbow.

A.4 COMBIMAN STRENGTH

COMBIMAN has a Strength Analysis function which computes the amount of force a crew member can exert on a control. The instructions for the use of this function are contained in Section 7 of this user's guide. The data bases are for Arm Strength and Leg Strength.

A.4.1 Arm Strength

The arm strength predictions of COMBIMAN are based on two studies; "The Atlas of Seated Strength (HERCULES) Study" and "The Pilot Strength Study". The HERCULES study was conducted at the

AAMRL Ergonomics Laboratory at WPAFB, OH. The Pilot Strength study was conducted at the US Air Force Academy and Officers Training School. Detailed descriptions of these studies are contained in two unpublished documents: "UDR-TR-85-19, 'Biomechanics for Crewstation Design', pages 14-27 and 35-40, edited by Gibbons, 1985" and "UDR-TR-86-112, 'The COMBIMAN Programmers and Developers Guide, Vol. II', pages 22-34, by Quinn, Robbins and Lai, 1986".

The HERCULES study was used to determine the effect of two variables. First, the location at which force is applied. Second, the direction in which force is applied. The Pilot Strength study was used to scale the strength values of the HERCULES study for a better estimation of the strength capabilities of the Air Force population of pilots.

The HERCULES study compiled data on over 30 male and 30 female subjects. Each subject exerted force in six different directions at each of the 76 handle locations used in the study. The six directions consisted of a forward push (FORE), a pull (AFT), a lateral force to the right (RIGHT), a lateral force to the left (LEFT), an upward force (UP), and downward force (DOWN). The terms in the parentheses indicate the corresponding terminology used in the Strength Analysis function.

The 76 locations form a three dimensional grid of vertices which are spaced 10 inches apart in the X, Y or Z directions. Thus, the vertices form ten inch cubes stacked side by side, in front and behind, and on top and below each other. The force

magnitudes and their directions were collected at each of the 76 positions. The force magnitudes were averaged individually over all the male, and then female, subjects, the final product being the 76 X 6 averaged force magnitudes and directions for males and females, before applying the scaling factors derived from the Pilot Strength study.

The Pilot Strength study compiled data on approximately 250 female and 450 male subjects, from student populations at the Air Force Academy and Officers Training School. This study contains strength data corresponding to typical locations for stick and wheel controls. Force data were collected at the locations, and in the directions appropriate for the type control. The large data base was used to calculate strength percentiles for each direction of force. These percentiles were used as scaling factors for the HERCULES force data after a normalization process was performed on HERCULES data.

The normalization process consisted of several steps. The first step was to calculate an average force at each of the Pilot Strength study locations using a linear distance type of interpolation on the averages of the HERCULES force data. (The Pilot Strength data locations were located within one of the ten inch cubes. Each force average was weighted by the proximity of its corresponding location to the Pilot Strength study location). These averages were then used for the normalization of the HERCULES force data. Thus, each control type and force direction that is selectable in COMBIMAN arm strength has a corresponding normalized HERCULES data base. The closest normalized values

(values which form a 'cube' around location selected for prediction) are used for interpolation of the predicted normalized whole. The final prediction consists of the 1st, 5th, 50th, 95th and 99th percentiles multiplied by the normalized value. Thus, these final percentiles are based on the Air Force population of pilots.

NOTE 1: COMBIMAN does not allow prediction of force values at locations outside the range of the 76 locations of the HERCULES study.

NOTE 2: The two arm wheel predictions cannot use the HERCULES data base. The percentiles are based on one location (assumed to be a weak estimate for each direction). The COMBIMAN does allow for some 'slop' in the location by assuming other reachable locations are stronger locations. The hands are assumed to be symmetric around the wheel. The wheel is assumed to have a center at Y=0, and an X coordinate between X=14 inches and X=24 inches, and a Z coordinate between Z=10 inches and Z=15 inches. The effective radius of the wheel is also assumed to be less than 10 inches. This is for the two arm reach on wheel predictions only.

A.4.2 Leg Strength

The same Pilot Strength study referenced in Paragraph A.4.1 and the Knee Angle study conducted at AAMRL's Ergonomic Laboratory were used as bases for the COMBIMAN leg strength predictions. Detailed descriptions are contained in the two unpublished documents cited in Paragraph A.4.1; pages 28-41 of UDR-TR-85-19, and pages 16-22 and 27-34 of UDR-TR-86-112.

The Knee Angle study was made to determine the relationship between leg strength, knee angle and vertical location of the rudder pedal. Data were collected on 10 male and 10 female subjects. The algorithm uses the knee angle and the vertical

rudder pedal offset from the Seat Reference Point (SRP) as independent variables. Although the algorithm allows a prediction over a knee angle range of 110 to 160 degrees, the most reliable range, given the data of the Knee Angle study, is 115 to 145 degrees. The algorithm also allows a prediction outside the data collection range of the vertical offset of the rudder pedal (from the SRP). The data were compiled at vertical offsets of -5.5 and -10.5 inches from the SRP. The algorithm allows predictions from -3.0 to -12.0 inches of vertical offset from the SRP.

The large data base of the Pilot Strength study allowed calculation of strength percentiles relating directly to the Air Force population of pilots. The leg strength data were compiled at approximate positions of maximal leg strength for each subject. These were compiled for both the right and left legs of each subject. Percentiles were calculated for each leg and each gender of the total subject population. These percentile values were used as straight scaling factors to the normalized leg strength prediction model obtained from the Knee Angle study.

A.5 ANTHROPOMETRIC SURVEYS AND COMBIMAN ANTHROPOMETRIC DATA BASE MAINTENANCE PROGRAM (CBMAM)

The six anthropometric survey members used in COMBIMAN to generate the man-model link system are:

1. R67 USAF - US Air Force Male Pilots and Navigators
1. R68 AFW - US Air Force Enlisted Women
3. R68 AFFW - US Air Force Female Pilots and Navigators
4. R70 ARMY - US Army Aviators
5. R77 ARMW - US Army Female Personnel

6. R64 NAVY - US Navy Male Flying Personnel

The six members are based on large anthropometric surveys, or subsets of those surveys.

The R67 USAF survey member is based on the 1967 Survey of USAF Flying Personnel. One hundred eighty-six body dimensions and grip strength measurements were made on 2420 US Air Force males, all of whom were officers on flying status. Forty-nine percent of the sample were rated pilots, 21% were student pilots, 21% were rated navigators and 8% were student navigators. A few flight surgeons were also included in the sample. To develop the survey member, the 1967 Survey of USAF Flying Personnel was edited, using the Air Force criteria for age, height and weight current at the time of the survey development. Data for subjects not meeting the age, height and weight criteria were not included in the survey member development. The means, standard deviations and percentiles for each variable required to generate the man-model were derived from the subset of data.

The 1968 Survey of US Air Force Women is the basis for two survey members, R68 AFW and R68 AFFW. The 1968 Survey of US Air Force Women measured 123 body dimensions, plus grip strength, for 1905 active duty Air Force women. The subjects ranged in grade and rank from basic trainee to colonel, and were from 18 to 57 years of age. Twenty-nine percent of the subjects were officers, 5% were officer trainees, and the remainder were enlisted women. Most of the officers (5 out of 6) were nurses, and half of the remaining officers were in the biomedical sciences classifications.

The medical and dental fields accounted for 52%, and the administrative fields for 16%, of the enlisted women, with the remainder from a broad variety of fields.

The subset of data for the R68 AFW survey member was derived by applying the following criteria:

- Height - 59.75 to 80.25 inches
- Age - Less than 35 years
- Weight - As prescribed for the age and height in Table A.2.

The subset of data for the R68 AFFW survey member was derived by applying the following criteria:

- Height - 63.75 to 96.25 inches
- Height, Sitting - 33.75 to 39.25 inches
- Age - 21 to 27.5 years
- Weight - As prescribed in Table A.2.

Data for subjects not meeting these criteria were not included in developing the survey members. The means, standard deviations and percentile values for all but four of the variables were derived from the appropriate subset of data. The missing dimensions (Knee Height - Sitting, Shoulder - Elbow Length, Elbow - Grip Length, and Elbow - Wrist Length) were derived by constructing regression equations using data from the 1977 US Army Females Survey.

The R70 ARMY survey member is based on the 1970 Anthropometry of US Army Aviators survey, which made 85 measurements on 1482 male flying personnel. Means, standard deviations and percentile values for all but two variables (Biacromial Breadth and Elbow - Grip Length) were derived from the referenced survey. The missing values were derived by constructing regression

TABLE A.2
WEIGHT TABLE FOR FEMALES

FEMALES									
Height Inches	Minimum	Standard	18-20	21-25	26-30	Maximum			
						31-35	36-40	41 and Over	
58	87	100	120	124	126	129	132	135	
59	89	101	122	126	128	131	134	137	
60	92	103	124	128	130	133	136	139	
61	95	105	127	130	132	135	139	141	
62	97	107	128	132	134	137	140	144	
63	100	109	132	134	136	139	143	145	
64	103	111	135	136	139	143	145	149	
65	106	114	138	140	144	148	150	153	
66	108	118	141	145	148	151	154	157	
67	111	122	145	149	152	156	158	162	
68	114	125	150	153	156	160	162	166	
69	117	128	154	157	161	164	167	170	
70	119	132	158	162	165	168	171	174	
71	122	135	162	166	169	173	175	179	
72	125	139	167	171	174	178	181	184	
73	128	144	171	177	179	183	186	190	
74	130	148	175	182	185	188	191	195	
75	133	152	179	187	190	194	196	200	
76	136	156	184	192	196	199	202	205	
77	139	161	188	197	201	204	207	211	
78	141	165	192	203	206	209	213	216	
79	144	169	196	208	211	215	218	220	
80	147	173	201	213	216	219	223	225	

equations based on the 1967 US Air Force Survey of Flying Personnel.

The R77 ARMW survey member is based on the 1977 US Army Females Survey. The means, standard deviations and percentile values for the required variables are derived directly from the referenced survey.

The R64 NAVY survey member is based on the 1964 Navy Flyers Survey, in which 96 measurements were made on 1549 navy aviators. All required dimensions are obtained direct from the survey, except for Biacromial Breadth and Elbow - Grip Length. Missing dimensions were predicted from regression equations based on the 1967 US Air Force Survey of Flying Personnel.

The survey selected to generate the man-model depends on the analysis to be made. For example, if you, the user, wanted to assess the placement of a control in the cockpit of an aircraft to be flown by both male and female Air Force pilots the analysis would require two steps. First you would select the R67 USAF survey to generate the man-model and make your assessment of control location for Air Force male pilots. When that assessment is completed you would regenerate the man-model by selecting the R68 AFFW survey and make the same assessment of the control location. This would give you the required assessment of the control location for both male and female Air Force pilots. Basically, you choose the survey(s) that best represent the population you are concerned with.

If the user requires an additional survey, this appendix describes how to create the data base using the supplied utility program, CBMAM. This data base resides on a direct-access disk, and contains anthropometric survey and regression data which are relevant to generate the man-model.

The information on the Data Base is organized into groups of related records called members. Members may be either regression data, or anthropometric survey data. Data for survey members are generally subsets of existing anthropometric surveys in the AAMRL Anthropometric Data Bank. In order to add a new anthropometric survey to the Data Base, the key information needed includes the mean and standard deviation for each anthropometric variable and a set of correlation coefficients for all the relevant variables of the survey.

A.5.1 Processing Capabilities

The program CBMAM (COMBIMAN Anthropometric Data Base Maintenance Program) allows the user to create and maintain the Anthropometric Data Base. The user supplies the input data on 80 character computer cards or in card image format on magnetic tape. The program CBMAM reads and processes the data in accordance with the selection of control commands by the user. These commands allow the user to add members to the Data Base, to delete members from the Data Base, to print or punch existing members, to list the directory of the Data Base, or to compress the data on the file to combine unused space. The data flow of the program is shown in Figure A.4.

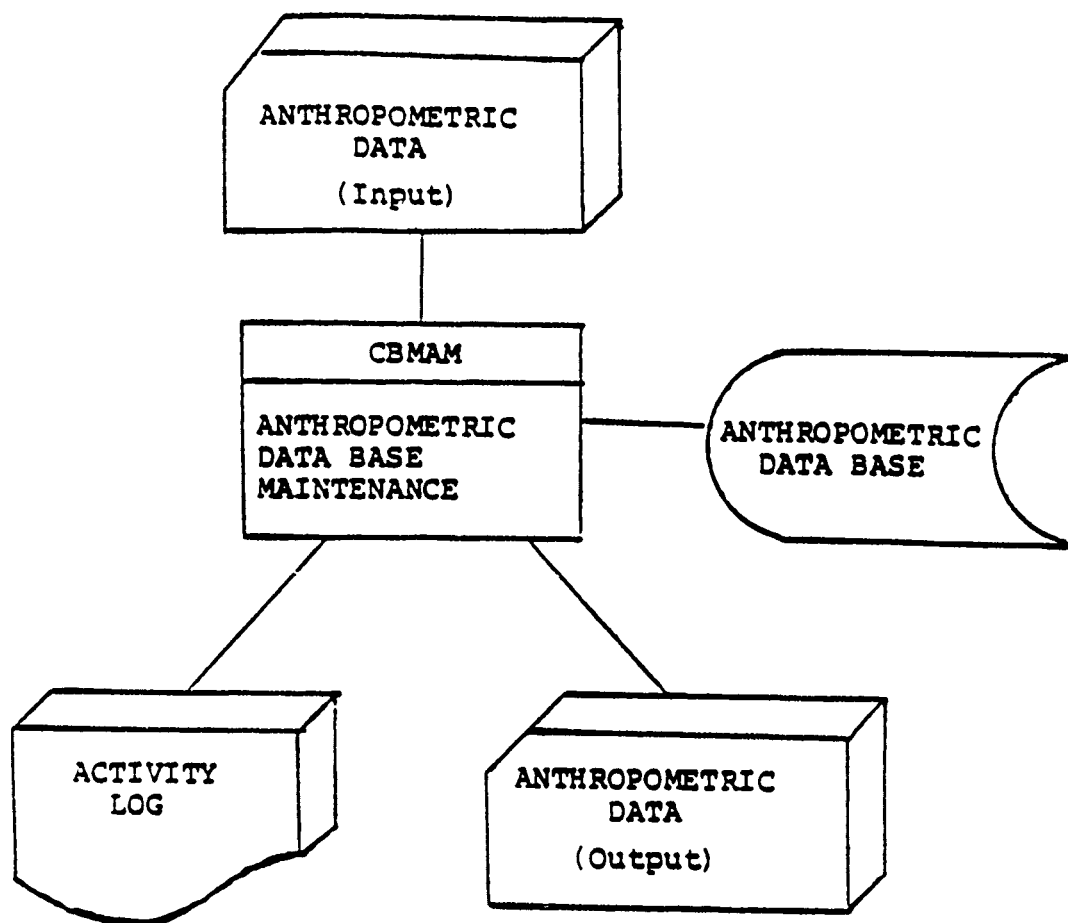


Figure A.4. Data Flow for Program CBMAM.

The Anthropometric Data Base is made up of two types of related data. One type consists of regression data which are used by the interactive graphics program CBM08 to compute the anthropometric surface dimensions needed to generate the link system of the man-model. The second type consists of survey data which define the means, standard deviations, and percentiles for each variable for a particular survey. Each group of data, whether dealing with regression or survey information, is called an anthropometric member, and is referenced by its member name and type classification.

A.5.2 Restrictions and Limitations

The Anthropometric Data Base may contain up to a maximum of 20 members consisting of regression and survey types. The number of records for each member need not be the same and the sum of the record counts for all the members cannot exceed 1979. Information on the number of members on the Data Base and their sizes is obtained by using the "+PRT" control command as explained in detail in Paragraph A.5.3.2.9.

Additional limitations on the number of variables and related data are explained in Paragraph A.5.3.2. Members to be added should have unique membernames. If the new membername matches with any name in the directory, the member will not be added.

A.5.3 How To Use Program CBMAM

The surveys used in COMBIMAN are subsets of the 1967 Survey of the USAF Flying Personnel (Churchill, et al., 1976), the 1970 Survey of the U.S. Army Aviators (Churchill, et al., 1971), the 1968 Air Force Women, and the 1964 U.S. Navy Flyers. As new surveys become available, or subsets of existing surveys in the AAMRL Data Bank become needed, the program CBMAM is used to add these new members. In most cases, each new survey type member has a corresponding regression type member which contains multiple and single regression equation coefficients to predict additional anthropometric variables from those specified by the user. In a few cases, one regression type member may be referenced by several survey type members. These are special cases and this practice should not be used regularly without first consulting with personnel in the Workload and Ergonomics Branch of the Armstrong Aerospace Medical Research Lab, Wright-Patterson Air Force Base, Ohio to verify the statistical accuracy of the regression data of the anthropometric survey in question.

All examples illustrating use of CBMAM will be based on the 1967 USAF Flying Personnel survey and its regression member R67 USAF.

A.5.3.1 Input Data Specification

The nucleus of the anthropometric variables considered for input as part of any anthropometric survey member is the 12 variables required to generate the 35 internal link lengths of the man-model skeletal system. The names of these variables and

their abbreviated 16 character names, where applicable, are listed in Table A.1. Very few COMBIMAN users will have specific values to input for each of the 12 variables. In order to accommodate this, we have selected additional anthropometric variables which are found to be good predictors of either body segment mass or body segment length, and have moderately high correlations with the 12 required variables. The variables chosen to predict mass and length related variables for the 1967 Survey are shown in the appropriate columns of Table A.3. The variables in Table A.4 which are both predictors and required dependent dimensions are marked with an asterisk.

To generate the man-model the user may also select one mass related and one length related variable from Table A.3 and supply their values. The values for all the 12 variables in Table A.1 are computed using the regression equations from the Anthropometric Data Base.

In order to create an anthropometric survey member, first a set of variables based on availability and necessity has to be established. Once the complete set of variables is established, the means, standard deviations, percentiles, and correlation coefficients for each variable of the particular survey may be obtained from the AAMRL Anthropometric Data Bank. The set of variables used for the 1967 Survey is shown in Table A.4. A sample data obtained for weight is shown in Figure A.5.

The coefficients used in the regression equations are based on means, standard deviations and correlation coefficient for

TABLE A.3
LIST OF DEPENDENT VARIABLE PREDICTORS

<u>Mass Related</u>	<u>Length Related</u>
1. *Weight	1. *Sitting Height
2. Bideloid Breadth	2. Eye Height, Sitting
3. Hip Breadth, Sitting	3. *Knee Height, Sitting
4. *Chest Depth	4. *Buttock-Knee Length
	5. Arm Length
	6. Thumb-Tip Reach
	7. Leg Length

*Predictors and required dependent variables.

TABLE A.4
LIST OF ANTHROPOMETRIC DIMENSIONS
AVAILABLE IN THE ANTHROPOMETRIC DATA BASE

1. Weight
2. Sitting Height
3. Eye Height, Sitting
4. Acromion Height, Sitting
5. Knee Height, Sitting
6. Buttock-Knee Length
7. Shoulder-Elbow Length
8. Arm Length
9. Thumb-Tip Reach
10. Biacromial Breadth
11. Bideloid Breadth
12. Hip Breadth
13. Hip Breadth, Sitting
14. Chest Depth
15. Foot Length
16. Hand Length
17. Elbow-Wrist Length
18. Leg Length

VARIABLE NAME: WEIGHT										
MEAN: 173.60 LBS										
STANDARD DEVIATION: 21.44 LBS										
PERCENTILE DATA:										
Percentile	1	2	3	5	10	15	20	25	30	
Weight	127.58	132.63	135.82	140.15	146.89	151.53	155.27	158.56	161.56	
Percentile	35	40	45	50	55	60	65	70	75	
Weight	164.37	167.08	169.74	172.42	175.13	177.92	180.84	183.97	187.41	
Percentile	80	85	90	95	97	98	99			
Weight	191.32	195.91	201.83	210.76	216.62	220.94	227.73			

Figure A.5. Sample Data Obtained from Summary Statistics of the Air Force Rated Officers. (Churchill, et. al., 1976)

each variable, and on the equations which were developed in WADD-TR-60-31, pages 69-70 (Zeigen, et al, 1960). Tables A.5 and A.6 show the elements of the correlation coefficient matrices used in calculating the regression coefficients. The means, standard deviations, and correlation coefficients for the 1967 USAF survey are available in AMRL-TR-77-2 (Churchill, et al, 1976).

The total number of multiple regression equations (NR) needed for a particular survey is calculated using the following equation:

$$NR = (NM \times NL) \times ND \quad (1)$$

where NM is the number of variables related to body mass, NL is the number of variables related to body segment length, and ND is the number of dependent variables. For the 1967 Survey, each of the 28 combinations of mass-length-related dimensions has its own set of 12 multiple regression equations to compute the surface dimensions required to generate the man-model. In addition to the multiple regression coefficients, simple regression coefficients and associated standard error of estimates are available for each of the 28 combinations. Note that the standard units of measurement for all variables used in COMBIMAN are pounds and inches, but there are provisions to change these into metric units.

A.5.3.2 Processing Specification

The Anthropometric Data Base Maintenance program, CBMAM, allows the user to create and maintain the Anthropometric Data Base. The Data Base contains regression data which are used by

TABLE A.5
MATRIX OF CORRELATION COEFFICIENTS BETWEEN
MASS AND LENGTH RELATED VARIABLES (Churchill, et al., 1976)

	Sitting Height	Eye Hgt. Sitting	Knee Hgt. Sitting	Butt-Knee Length	Elbow- Grip Length	Thumb- Tip Reach
Weight	.4568	.4119	.5386	.4544	.4085	.4138
Bideltoid Brdth.	.2782	.2598	.3398	.4379	.2514	.2784
Hip Brdth., Sitting	.3755	.3457	.4283	.5502	.3432	.3270
Chest Depth	.3333	.3070	.4084	.5479	.2882	.2965

TABLE A.6
DEPENDENT AND INDEPENDENT VARIABLES
(Churchill, et al., 1976)

DEPENDENT VARIABLES	INDEPENDENT VARIABLES									
	Weight	Stature	Weight (S)	Height (S)	Weight (S)	Buttock- Knee Length	Crip Length	Thigh- Top	Shoulder Breadth	Weight (S)
Weight	1.00	.4576	.4130	.5390	.6361	.4080	.4143	.7966	.8549	.7594
Sitting Height	.4568	1.00	.9302	.5148	.3917	.6613	.4138	.2782	.3333	.1299
Acromion Height (S)	.4862	.8126	.7780	.4452	.3382	.3823	.3482	.2676	.3916	.2008
Knee Height (S)	.5386	.5148	.4876	1.00	.7851	.7017	.7002	.3398	.4084	.2853
Buttock-Knee Length	.6363	.3917	.3897	.7851	1.00	.6238	.6041	.4379	.5479	.4168
Shoulder-Elbow Length	.3995	.4573	.4584	.7500	.6967	.6743	.6752	.2515	.2997	.2092
Biaxromial Breadth	.4516	.3491	.2964	.3745	.2954	.3481	.3235	.6571	.3202	.2681
Hip Breadth	.8094	.3755	.3457	.4283	.5502	.3432	.3270	.6225	.9011	.5893
Chest Depth	.7593	.1299	.1065	.2853	.4168	.2034	.2523	.6240	.6318	1.00
Foot Length	.4711	.4786	.4497	.6919	.5957	.6517	.5545	.3067	.3498	.2445
Hand Length	.3889	.4506	.4155	.4534	.5432	.7070	.5757	.2553	.2578	.2005
Elbow-Wrist Length	.4116	.4340	.3899	.7826	.6260	.8994	.6865	.2619	.2993	.2122

the interactive graphics program CBM08 to predict anthropometric surface dimensions needed to generate the link system of the man-model. It also contains survey data which define the means, standard deviations, and percentiles for every defined variable for a particular anthropometric survey. Each group of data, whether dealing with regression or survey information, is called an anthropometric member, and is referenced by its member name and type classification.

The program CBMAM allows the user to maintain the Data Base by adding, deleting, listing, etc., the member types through input control cards as shown in Figure A.6.

These control cards may be placed in any order in the stream of the program, with one exception. If the Data Base is initialized for the first time, the +INT control card must be the first data card. In the following paragraphs, the control cards format of the function is listed first. This is followed by the text which explains each keyword. Additional data formats, if any, are then described for each function.

A.5.3.2.1 ADD ANTHROPOMETRIC MEMBER Function
+ADD membername type nvbl ncmb ndep regrname (followed
by member definition)

The ADD ANTHROPOMETRIC MEMBER function, as defined by the +ADD control card and the member definition cards which follow, adds to the Anthropometric Data Base specified data under the name membername. The membername is an alphanumeric character string, whose length is limited to 16 characters. The type field distinguishes between the two types of members. A type value of

"0" indicates that the member regression information, while a type value of "1" indicates that the member contains survey dimension data. The type value, as well as all other integer values supplied on the control card, must be right-justified within its field. The nvbl field defines the total number of variables described in member membername. The maximum number is 45. The ncmb field indicates the maximum number of combinations of independent mass and length variables. The maximum number is 50. The number of anthropometric variables needed to determine the internal link lengths is supplied in field ndep. The maximum number is 30. Fields, npct and regrname are used only when the type field value is 1. Npct contains the number of percentile values which will be supplied for every one of the nvbl variables. The maximum value for npct is 30. The regrname field refers to the type 0 membername which contains the appropriate regression information.

A.5.3.2.2 Type 0 Members

An example of a +ADD control card for a type 0 member in the 1967 Survey is outlined in Figure A.7. The name of the survey member is R67 USAF, and it contains a total of 18 variables, with 28 combinations of independent variables, and 12 combinations of dependent variables. An example of a +ADD control card for a type 1 member is outlined in Figure A.8. Note that the values for nvbl, ncmb, and ndep are identical to the type 0 member R67 USAF, shown in Figure A.7.

+ADD R67 USAF 0 13 28 12									
1	WEIGHT	LB							
2	SITTING HEIGHT	IN							
3	EYE HGT/SITTING	IN							
4	ACROMION HGT/ST	IN							
5	ARM LENGTH	IN							
6	THUMB-TIP REACH	IN							
7	SHOULDER-CLB LGTH	IN							
8	KNEE FG/SITTING	IN							
9	BUTTOCK-KNEE LGTH	IN							
10	BIACRCHIAL BRDTH	IN							

Figure A.7. Example of +ADD Control Card for Type 0 Member

+ADD	27	USAF	1	10	28	12	25	KG7	USAF
1	2	3	5101520253035404550556065707580859095979899						
1	W	L	G	H					
1552715050161501643716708169741724217513177921800418397107411913219591									
2010321076216622209422773									
2	S	I	T	T	I	N	G	H	E
35623502360030173033364930053581369837153733375337753801									
38333800391039313902									
3	E	Y	E	H	G	I	S	I	T
30073106312331303153310031033190321332293246326532863311									
33433350342134433478									
4	A	L	K	M	I	N	G	H	E
24102327234323562373230724012415243024452461247424992522									
25512554262026392606									

Figure A.8. Example of +ADD Control Card for TYPE1 Member

Figures A.9, A.10, and A.11 show the record formats used for type 0 members in the data base. The data provided in the format shown in Figure A.10 defined anthropometric variables used in the regression member. Columns 1-2 contain a sequence number for the variable, right-justified in the field. Columns 4-19 contain the 16-character name of the anthropometric variable. Columns 21-22 contain a two-character abbreviation for the default unit of measurement of the variable. Approved abbreviations are IN, CM, MM, LB, and KG for inches, centimeters, millimeters, pounds, and kilograms, respectively. A "1" punched in column 26, 30, or 34, indicates a mass related independent variable, a length related independent variable, or a dependent variable necessary to generate the link lengths respectively. A variable can either be independent or dependent, as in the case of sitting height, but it cannot pertain to both mass and length. If all three fields are blank, the data card is flagged to indicate an error. As each variable definition card is read in, the program checks the use of the variable and records its status.

The first outlined area of Figure A.12 is an example of a Variable Definition Card. A "1" is punched in columns 30 and 34 to indicate that the Sitting Height is both an independent variable related to body segment length and a dependent variable.

Two types of record formats are used for combinations of mass and length related independent variables as shown in Figures A.10 and A.11. In Figure A.10, the variable numbers, punched in columns 1-3 and 4-6 are obtained from columns 1-2 of the variable definition cards as shown in Figure A.9. Columns 11-40 contain

*AJO R67 USAF 0 18 28 12									
1	WEIGHT	LB	1	1					
2	SITTING HEIGHT	IN	1	1					(1)
3	EYE HGT/SITTING	IN	1						
4	ACROMION HGT/SIT	IN		1					
5	ARM LENGTH	IN		1					
6	THUMB-TIP REACH	IN		1					
7	SHOULDER-ELB LGTH	IN			1				
8	KNEE HGT/SITTING	IN		1	1				
9	BUTTOCK-KNE LGTH	IN		1	1				
10	DIACRCHIAL BROTH	IN			1				
11	BIOELTIOO BROTH	IN	1						
12	HIP BREADTH	IN			1				
13	HIP BREADTH/SITT	IN	1						
14	CHEST DEPTH	IN	1		1				
15	FCOT LENGTH	IN			1				
16	HAND LENGTH	IN			1				
17	ELBOW-WAIST LGTH	IN			1				
18	LEG LENGTH	IN		1					
1	2	0.02669	32.05275	1.11161	7.84538-114.20831	19.05910			(2)
1	2	1	1.0	0.0	0.0				
1	2	2	0.0	1.000000	0.0				
1	2	4		.731	-2.779522				
1	2	7		.247	5.090541				
1	2	8		.404	7.133844				(3)
1	2	9		.333	11.566906				
1	2	10	0.0131732	0.1105000	9.64417				
1	2	12	0.0279173	0.0043000	8.87957				(4)
1	2	14	0.0313031	0.1665000	10.32958				
1	2	15	0.0069724	0.1248000	4.85468				
1	2	16		.117	3.232277				
1	2	17		.193	4.728337				
1	3		0.02267	27.89858	1.08116	7.45657 -64.02781	19.52158		
1	3	1	1.0	0.0	0.0				
1	3	2		0.979	5.48424				
1	3	4		0.737	0.99118				

Figure A.12 Example of Regression, or Type 0 Member.

simple regression information necessary to predict the length related variable from the mass related variables. This information includes the slope and constant in the regression formula:

$$Y = bX + c \quad (2)$$

where

b is the slope and
c is the intercept.

It also contains the standard error of estimate associated with the equation. Columns 41-70 contain similar data to predict mass from the length variable.

The regression data used in the following examples are unpublished data provided by the USAF. These data contain the slope, intercept, and standard error in metric units. The coefficients are multiplied by appropriate factors to convert them to the English units specified on the Variable Definition Card.

The regression equation to predict sitting height in inches from weight in pounds is:

$$\begin{array}{lcl} \text{Estimated Sitting Height} & = & 0.02669 \times \text{Actual Weight} + 32.05275 \\ \text{(Variable \#2)} & & \text{(Variable \#1)} \end{array} \quad (1)$$

The standard error is 1.11161.

The equation to predict weight in pounds from sitting height in inches is:

$$\text{Estimated Weight} = 7.84538 \times \text{Actual Sitting Height} - 114.20831 \quad (2)$$

The standard error is 19.05920.

In Figure A.12 (2), the "1" in column 3 identifies Weight as the mass related variable, and the "2" in column 6 identifies Sitting Height as the length related variable. The regression

coefficients for equations (1) and (2) are punched in the remainder of the card.

The second record format is shown in Figure A.11 and contains the multiple regression information necessary to predict each dependent variable from the particular combination of mass and length related variables. Columns 1-3 contain the independent mass variable number; columns 4-6 the independent length variable number; and columns 7-9 the dependent variable number. Each integer value must be right-justified. Columns 11-20 contain the slope associated with the mass variable value (b_1); and columns 21-30 the slope for the length variable value (b_2); and columns 31-40 the constant of the equation (c). The equation to predict the value y of a dependent variable is of the form:

$$Y = b_1 X_1 + b_2 X_2 + c \quad (3)$$

where:

X_1 is the value of mass related variable and

X_2 is the value of length related variable.

The data for this card are derived from the correlation matrices shown in Tables A.5 and A.6, and from the equations in Zeigen, et al, (1960). Since it is undesirable to have the length related variables to depend on the value chosen for the mass related variable, the multiple regression equations are replaced by single regression equations. As an example, the multiple regression equation to predict Knee Height/Sitting from Weight and Sitting Height is replaced by a single regression equation as follows:

$$\begin{aligned} \text{Knee Height/Sitting} &= 0.00 \times \text{Weight} && (\text{Variable \#1}) \\ &+ 0.40400 \times \text{Sitting Height} && (\text{Variable \#2}) \\ &+ 7.133844 \end{aligned}$$

The third outlined area of Figure A.12 shows the data for this example. A "1" in column 3 identifies Weight as the mass variable; a "2" in column 6 identifies Sitting Height as the length variable; and a "5" in column 9 identifies Knee Height/Sitting as the dependent variable. The regression coefficients are punched in the remainder of the card.

The multiple regression equations are retained for predicting the mass-related variables. As an example, the multiple regression equation to predict Hip Breadth from Weight and Sitting Height is as follows:

$$\begin{aligned} + \quad \text{Hip breadth} &= 0.0279173 \times \text{Weight} && (\text{Variable \#1}) \\ &+ 0.0043000 \times \text{Sitting Height} && (\text{Variable \#2}) \\ &+ 8.87957 \end{aligned}$$

The fourth outlined area of Figure A.12 shows the data for this example. A "1" in column 3 identifies Weight as the mass variable; a "2" in column 6 identifies Sitting Height as the length variable; and a "12" in columns 8 and 9 identifies Hip Breadth as the dependent variable. The regression coefficients are punched in the remainder of the card.

If the number of multiple regression coefficient definition data cards is not equal to (ncmb x ndep) the member is not added to the Anthropometric Data Base.

A.5.3.2.3 Type 1 Members

For type 1 members on the Data Base, the record formats are shown in Figure A.13 and A.14. The input data in the format shown in Figure A.22 defines the percentile names for which values are supplied in succeeding cards. Figure A.15 shows the percentile names for the 1967 USAF Survey. The 25 percentile values available for this survey include the 1st, 2nd, 3rd, 5th, and are punched in two-digit integer fields, right-justified within the area. The number of percentiles supplied must be equal to the value in the npct field of the +ADD (type 1) control card, otherwise an error message is printed and the member is not added. Note that the maximum number of percentiles allowed is 30.

Figure A.14 shows the format used in assigning dimensional values to the variables. The variable number in integer format is in columns 1-2 while columns 4-19 contain the 16-character variable name. Columns 21-22 contain the two character abbreviation for the default unit of measurement. At present the default or standard unit for weight is pounds, and the standard unit for all other measurements is inches. For each variable number, the variable name and unit of measurement must correspond with the same fields in the reference type 0 or regression member. Columns 23-32 contain the overall mean for the named variable expressed in the default unit of measurement. Columns 33-42 contain the standard deviation. Columns 43-72 of this data card and columns 1-70 of additional cards necessary to input data contain the values for each of the percentiles named. If the

*ADD 51	USAF	1	18	20	12	25	R67	USAF	→
1	2	3	5101520	53055404550556065707580859095979899					
1	WEIGHT		LB	173.60086	21.434704	127581326313582140151468915153			
1552	715050161501543716708169741724217513177921808418397187411913219591								
2018	321076216622209422713								
2	SITTING HEIGHT	IN	36.085932	1.2501624	3394	3424	3444	3470	3511 3539
3562	3582	3600	3617	3633	3649	3665	3681	3698	3715 3733 3753 3775 3801
3833	3850	3910	3931	3962					
3	EYE HEIGHT/SITTING	IN	31.069176	1.1871142	2917	2950	2971	2998	3038 3065
3087	3106	3123	3138	3153	3168	3183	3198	3213	3229 3246 3265 3286 3311
3343	3350	3421	3443	3478					
4	ALCUMIUM HGT/SEI	IN	24.03821	1.123410	2142	2177	2191	2224	2263 2289
2310	2327	2343	2358	2373	2387	2401	2415	2430	2445 2461 2479 2499 2522
2551	2554	2620	2639	2666					
5	ARM LENGTH	IN	31.07249	1.34508	2802	2857	2859	2890	2937 2969
2995	3017	3037	3056	3073	3091	3108	3125	3142	3160 3179 3199 3223 3250
3284	3335	3369	3394	3434					
6	THUMB-TIP REACH	IN	31.62047	1.56458	2804	2840	2872	2908	2964 3001
3030	3056	3079	3100	3120	3139	3158	3178	3198	3218 3240 3264 3291 3322
3364	3427	3469	3502	3555					
7	SHOULDER-ELB LENGTH	IN	14.15382	.614011	1265	1281	1291	1306	1329 1345

Figure A.15. Example of Survey, or Type 1, Member

number of percentile values does not correspond to the value of npct, an error condition occurs and the member is not added to the Data Base. The period in the fields in Figures A.13 and A.14 indicates the standard or default location of the decimal point in real number format.

The dimension data needed in this card are also obtained from the Summary Statistics of the 1967 Survey (Churchill et al, 1976). A sample set of the data for Weight is shown in Figure A.5. The mean value of Weight, 173.60686 lb., the standard deviation, 21.434704, and the weights associated with the first six percentiles, namely the 1st, 2nd, 3rd, 5th, 10th, and 15th are punched on the third card shown in Figure A.15. The weight values for the percentiles ranging from 20th to 85th, and from 90th to 99th, are punched in the last card. It is essential that users enter a type 1 member, since the type 1 member references the type 0 member.

A.5.3.2.4 CHECK ANTHROPOMETRIC MEMBER Function

The CHECK ANTHROPOMETRIC MEMBER function operates the same way as the +ADD ANTHROPOMETRIC MEMBER function. However, the member is not added but the data are checked for errors.

A.5.3.2.5 DELETE ANTHROPOMETRIC MEMBER Function

+DEL membername type

The DELETE ANTHROPOMETRIC MEMBER function removes the specified member from the Data Base, but does not make the space

occupied by the member available for reuse. The +CMP function must be used to accomplish this.

A.5.3.2.6 COMPRESS ANTHROPOMETRIC DATA BASE Function

+CMP

The COMPRESS ANTHROPOMETRIC DATA BASE function makes space available for storing anthropometric data by compressing used space together and maximizing the amount of continuous unused space on the Data Base. The intermediate blocks of unused space are created by the DELETE ANTHROPOMETRIC MEMBER function. The greater the activity of the Anthropometric Data Base (i.e., +ADD's and +DEL's), the more often it becomes necessary to use this +CMP function. If the message "CBM310A INSUFFICIENT SPACE REMAINING TO ADD MEMBER membername" appears while adding a member, it becomes necessary to use the +CMP function. If the +ADD function gives the CBM310 message immediately following the +CMP function, the Data Base is full and no new members can be added until an existing member is deleted from the Data Base.

A.5.3.2.7 DUMP ANTHROPOMETRIC MEMBER Function

+DMP membername type

+DMP

The DUMP ANTHROPOMETRIC MEMBER function prints the contents of the anthropometric member membername of specified type, or prints the complete Anthropometric Data Base if no membername is given on the control card. This function is used primarily by system programmers to check the contents of the file.

A.5.3.2.8 END PROGRAM Function

+END

The END PROGRAM function control card terminates execution of the program CBMAM and returns control to the operating system.

A.5.3.2.9 INITIALIZE ANTHROPOMETRIC DATA BASE Function

+INT

The INITIALIZE ANTHROPOMETRIC DATA BASE function initializes an Anthropometric Data Base or resets an existing Anthropometric Data Base to its original unused state. All members residing on the Data Base before invoking this function are purged and the entire space is made available for new members. However, the primary purpose of this function is to establish an Anthropometric Data Base.

A.5.3.2.10 PUNCH ANTHROPOMETRIC MEMBER Function

+PCH membername type

The PUNCH ANTHROPOMETRIC MEMBER function punches a copy of the specified member in the same format as the ADD ANTHROPOMETRIC MEMBER function input data for the specified type onto computer cards. If the user specifies a membername that does not exist on the directory, all the member names on the Data Base directory are printed out. This function does not add or remove any member from the Data Base.

A.5.3.2.11 PRINT ANTHROPOMETRIC MEMBER Function

+PRT membername type

+PRT

The PRINT ANTHROPOMETRIC MEMBER function prints the contents of the specified member, membername, of type, type, in a format similar to that used in the ADD ANTHROPOMETRIC MEMBER function. If no name is specified, or if a name that is not in the Data Base directory is specified, names of all members in the Data Base directory, the number of records for each member, their types, and any additional data supplied on the +ADD control card when the members were added to the Data Base are printed.

A.5.3.3 Executing CBMAM Program

The set of JCL used at the HESS facility to execute the program CBMAM is shown in Figure A.16. Use of the //FT02F001 DD card as shown in Figure A.17 assumes that the space for the Data Base has already been allocated and catalogued. If for some reason this condition is not met, the //FT02F001 DD card in Figure A.16 should be replaced by the card sequence (3 cards) shown in Figure A.17. The job is executed with this replacement series once to allocate space for the dataset (file) on disk, and to catalogue the file. Thereafter the simplified //FT02F001 DD card shown in Figure A.16 is used to maintain the Data Base.

If the file has just been created, or if the user wants to reinitialize the file, the +INT control function is used before any other control function. The last control card read into the program should be the +END control card.

A.5.3.4 Output Data Interpretation

The program CBMAM generates output to the card punch, to the disk file, or to the printer depending on the function specified

//CBMAM	JCU MESS	00001000
//JUDLIM	UU USA=COMBIMAN.LUAULIB,DISP=SHR	00001100
//CBMAM	EXEC PGM=CBMAM	00001200
//FT02F001	UU USA=COMBIMAN.ANTHDATA,DISP=SHR	00001300
//FT05F001	UU DUNAME=SYSIN	00001400
//FT06F001	UU SYSOUT=A	00001500
//FT07F001	UU SYSOUT=B	00001600
//SYSUUUMP	UU SYSOUT=A	00001700
//SYSIN	UU *	00001800

CBMAM FUNCTION CONTROL CARDS AND
MEMBER DEFINITION DATA

//		00001900
//		

Figure A.16. Job Control Cards to Execute CBMAM.

//FT02F001	UU USA=COMBIMAN.ANTHDATA,UNIT=DISK,DISP=(NEW,CATLG),	00001300
//	VOL=SER=DISK01,SPACE=(240,2000),	00001310
//	ULC=(BLKSIZE=240,LRECL=240,RECFM=F0)	00001320

Figure A.17. FT02 DD Card to Allocate Space for
COMBIMAN.ANTHDATA and Execute CBMAM

on the control card. The formats for the printed output are discussed in this section. Punched records used the same format as the input data records discussed in Paragraph A.5.3.2.

Five basic types of formats are used by CBMAM when data are written on the printer. These format types, their use, and sample outputs are presented in the following paragraphs. Each type begins with the same heading, listing the program name, CBMAM, the date and time of the program execution, and a page number.

The first type of output is generated by the INITIALIZED, PUNCH, COMPRESS, DELETE, and END functions. The output indicates the beginning and end of processing associated with the specified function. For the COMPRESS function, additional messages which indicate that a particular member is or is not moved in the process of compressing used space are printed. An example of this format for the COMPRESS function is shown in Figure A.18.

The second type of output is generated by the PRINT or PUNCH functions when the +PRT or +PCH control cards are supplied with a blank membername field. This causes the program to list the index of the Data Base, which contains the location and type of each member. This information is printed in the following format:

```
nn.) membername, EXTENT=(n1, n2), TYPE=tt, nv VARIABLES, nc
      COMB OF INDEP, and DEPENDENT, np PERCENTILE,
      r-membername REFERENCED SURVEY.
```

where:

nn is the record number of its identification record
 within the directory.

CH01A0 --- AIRCRAFT MATERIAL SURVEY DATA BASE MAINTENANCE PROGRAM

CH01001 CMP NOT USAF
 CH01051 NOT USAF WAS IN PLACE.
 CH01151 NOT USAF WAS IN PLACE.
 CH01301 COMPRESSION FINISHED.
 CH01391 PROGRAM END.

Figure A.18. A Sample Output of the +CMP Function

n1	is the location of the first record of the data which defines this member.
n2	is the location of the last record of the data which defines this member.
tt	is the type code (0 or 1).
nv	is the total number of anthropometric variables defined for the member.
nc	is the number of combination of independent variables.
nd	is the number of dependent variables.
np	is the number of percentiles. Note: np=0 if tt=0.
r-membername	is the name of the referenced regression member. Note: r-membername is blank if tt=0.

This information was originally supplied to the Data Base on the +ADD control card. A sample output of the PRINT function is shown in Figure A.19.

The third type of output is generated by the DUMP ANTHROPOMETRIC DATA BASE function. This function is used primarily by systems programmers to locate causes of I/O (Input/Output) errors on the Data Base. For the member specified on the +DMP Control Card, a directory or index information is printed, using the output format previously described for the +PRT control card. Each record associated with the member is then printed in the following format;

```

RECORD nnn + = + (record in EBCDIC)           + = +
+ = + (record in hexadecimal)                 + = +
+ = + (remainder of record in hexadecimal)    + = +

```

where nnn is the location of the record in the Data Base. The record is printed in EBCDIC using 254A format and in hexadecimal

using a 10Z8 format. An example of the DUMP function printout is shown in Figure A.20.

The fourth output format is used by the CHECK, ADD, and PRINT functions when a type 0, or regression member is specified. The program CBMAM reads the control card and checks it for errors, and the information obtained from the control card is reformatted and written out to the printer. Following the control card information, each Variable Definition Card is printed. The format used to print the Variable Definition Card is as follows:

```
nn.) variablename, INDEP VBLS (MASS=ns, LENGTH=ns), DEP  
      VBL=ns, UNIT OF MEASUREMENT=uu
```

where:

nn	is the variable number
variablename	is the 16 character name of the variable
ns	0 means NO; 1 means YES
uu	is the unit of measurement assigned to the variable: IN, CM, MM, LB, or KG.

After the variable definition data, the regression data for each combination of independent variables are printed. The format is shown in Figure A.21. The terms are defined as follows:

n1	is the variable number for the mass-related variable
mass name	is the variable name for the mass-related variable
n2	is the variable number for the length-related variable

DEPENDENT VARIABLES (MASS & LENGTH)		DEPENDENT VARIABLE	REGRESSION COEFFICIENTS (B1, B2, CNST)
<u>n1 mass name</u>	<u>n2 length name</u>	SIMPLE REGR (B1, CNST, SE) - LENGTH FROM MASS	<u>bb. bbb</u> ₁ <u>cc. ccc</u> ₁ <u>ss. sss</u> ₁
		MASS FROM LENGTH	<u>bb. bbb</u> ₂ <u>cc. ccc</u> ₂ <u>ss. sss</u> ₂
<u>nd₁</u>	<u>dop vbi name₁</u>		<u>bb. bbb</u> ₁ ¹ <u>bb. bbb</u> ₁ ² <u>cc. cccc</u> ₁
:	:		:
<u>nd_{ndop}</u>	<u>dop vbi name_{ndop}</u>		<u>bb. bbb</u> _{ndop} ¹ <u>bb. bbb</u> _{ndop} ² <u>cc. cccc</u> _{ndop}

Figure A.21. Output Format Used for Type 0 Regression Data

length name	is the variable name for the length-related variable
bb.bbb ₁ ,bb.bbb ₂	is the slope used to predict (1) length variable from mass variable, and (2) mass variable from length variable
cc.ccc ₁ ,cc.ccc ₂	is the constant used to predict (1) length variable from mass variable, and (2) mass variable from length variable
ss.sss ₁ ,ss.sss ₂	is the standard error of the estimate of the equations
nd ₁ nd _{ndep}	are the variable numbers for the dependent variables
depname ₁ depname _{ndep}	are the variable names for the dependent variables
bb.bbbbb ₁ ¹	is the slope for the mass variable when predicting dependent variable _i , where i = 1, ndep
bb.bbbbb _{ndep} ¹	
bb.bbbbb ₁ ²	is the slope for the length variable when predicting dependent variable , where i = 1, ndep
bb.bbbbb _{ndep} ²	
cc.ccccc ₁ cc.ccccc _{ndep}	is the constant for the multiple regression equation to predict dependent variable , where i=1, ndep.

An example of the output in the fourth format for the +ADD control card is shown in Figures A.22 and A.23

The fifth output format is also used by the CHECK, ADD and PRINT functions, but only when the type code is 1, indicating a survey member. The program CBMAM reads the control card and checks it for errors, and reformats and prints the information on the card relevant to the number of records written to the Data Base. Following the control card information, the percentile names (such as 1, 2, 3, 50, 95, etc.) for the member are printed as part of a subheading. A maximum of 10 percentile names are

CUMAM --- ANTHROPMETRIC SURVEY DATA BASE MAINTENANCE PROGRAM
 7/11/83 10:36:15 PAGE 3

3 EYE HLTS/SITTING		SIMPLE REGR (BL, CNST, SE) -		LENGTH FROM MASS		MASS		LENGTH FROM MASS		MASS	
1 WEIGHT	2 SEATING HEIGHT	3 EYE HLTS/SITTING	4 ACROMION HG/SEIT	5 ARM LENGTH	6 THUMB-TIP REACH	7 SEATING HEIGHT	8 ACROMION HG/SEIT	9 BUTTUCK-KNE LGTH	10 BIACROMIAL BRDTH	11 HIP BREADTH	12 CHEST DEPTH
1.00000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.97900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.73700	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.26000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.40300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.34900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.08570	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00930	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.15870	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.12150	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.11300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.29526	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26.155	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-50.027	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19.134	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.94707	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.35904	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.43726	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.60757	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.57349	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.09244	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00304	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.07272	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.08647	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.20737	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.18333	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.36779	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.00030	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.33000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.25000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.29100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.43900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.41000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.08050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.00460	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.03620	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.12980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.11400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.24300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure A.23. A Sample Output of the +ADD Function for TYPE 1 Member

printed on one line. The survey data are then printed in the following format:

```
nn.) variablename uu mmm.mm ss.sss ppp.pp1 ... ppp.pp10  
      ppp.pp10    ... ppp.pp20  
      ppp.pp21    ... ppp.ppndep
```

where

nn	is the variable number
variablename	is the name of the anthropometric variable
uu	is the specified unit of measurement for the variable
mmm.mm	is the mean value for the variable
ss.sss	is the standard deviation for the variable
ppp.pp ₁ - ppp.pp _{npct}	are the percentile values associated with the percentile names for the anthropometric variables

An example of this fifth format is shown in Figure A.24.

A.5.4 Program Messages Including Error Correction

The program CBMAM prints out both information and action related messages. The message format is as follows:

```
CBM3nni      message text
```

where:

nn	is the message number
i	identifies the action code (I=Informational, A=Action to be performed), and
message text	is the text of the message.

Unless otherwise noted, all messages are issued by the routine CBMAM.

LMNAR --- ANTHROPOMETRIC SURVEY DATA BASE MAINTENANCE PROGRAM

LMN0001 +ADD 67 USAF 1 10 20 12 25 M67 USAF
LMN0110 MEMBER 67 USAF IS REPL 1 AND CONTAINS 10 ANTHROPOMETRIC VARIABLE NAMES.

NO.	VARIABLE NAME	UNIT	MEAN	STDEV	1	2	3	5	10	15	20	25	30	35
					40	45	50	55	60	65	70	75	80	85
1.1	HEIGHT	LM	173.61	21.435	127.50	132.63	135.82	140.15	146.09	151.53	155.27	158.56	161.56	164.37
2.1	STANDING REIGTH	IN	36.69	1.250	167.00	170.76	172.42	175.13	177.92	180.86	183.97	187.41	191.32	195.91
3.1	EYE HGT/STANDING	IN	31.87	1.187	201.83	210.76	216.62	220.96	227.73	235.39	242.35	249.42	256.60	264.01
4.1	ALCUM MM HGT/ST	IN	24.04	1.123	33.94	34.24	34.46	34.70	35.11	35.39	35.62	35.82	36.00	36.17
5.1	ARM LENGTH	IN	31.07	1.365	16.33	36.49	36.65	36.81	36.98	37.15	37.33	37.53	37.75	38.01
6.1	THUMB-TIP REACH	IN	31.42	1.565	30.33	30.80	30.90	30.98	31.06	31.13	31.23	31.30	31.41	31.51
7.1	SHOULDER-ELBOW LGTH	IN	14.15	0.674	31.53	31.60	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63
8.1	KNEE GGT/STANDING	IN	21.96	0.980	21.42	21.77	21.97	22.24	22.63	22.89	23.10	23.27	23.43	23.58
9.1	OUTDOOR-KNEE LGTH	IN	23.78	1.062	23.73	23.87	24.01	24.15	24.30	24.45	24.61	24.79	24.99	25.22
10.1	BIACRURAL BRDTH	IN	16.03	0.764	25.51	25.94	26.20	26.39	26.64	26.99	27.37	27.79	28.23	28.66
11.1	BIHEL BRDTH	IN	18.99	1.008	28.02	28.37	28.59	28.90	29.37	29.91	30.17	30.37	30.56	30.74
12.1	HIP BRDTH	IN	13.88	0.742	30.73	30.91	31.08	31.25	31.42	31.60	31.79	31.99	32.23	32.50
13.1	HIP BRDTH/SETH	IN	14.98	0.906	32.84	33.35	33.69	33.96	34.34	34.78	35.02	35.25	35.48	35.80
14.1	CHST DEPTH	IN	5.65	0.754	13.97	14.06	14.16	14.23	14.32	14.41	14.51	14.61	14.73	14.86
15.1	THUL LENGTH	IN	10.44	0.468	15.03	15.20	15.44	15.55	15.73	15.95	16.13	16.31	16.48	16.66

Figure A.24. A Sample Output of the +ADD Function for TYPE 0 Member

CBM300I Control card image (e.g. +ADD, +PRT, etc.).

Reason: The user submitted a control card.
System Action: Continues processing.
User Action: None.

CBM301A Operation - UNKNOWN OPERATION.

Reason: The operation on the control card (shown in the previous CBM300I Message) is unknown.
System Action: The control card is ignored.
User Action: Correct card, using a valid operation, and resubmit.

CBM302I INITIALIZED.

Reason: The user requested to initialize the Anthropometric Data Base using the INITIALIZE ANTHROPOMETRIC DATA BASE Function(+INT).
System Action: The Data Base is initialized.
User Action: None.

CBM303A NO NAME GIVEN; operation IGNORED.

Reason: The operation specified on the control card requires a membername; but no name was supplied.
System Action: The control card and subsequent data, if any, are ignored.
User Action: Correct the card, adding the appropriate additional information as required in the definition of the specific operation and resubmit.

CBM304A TYPE SPECIFICATION INVALID FOR MEMBER membername.

Reason: An invalid type code, that is, a type code other than 0 or 1, was given for the specified member.
System Action: Control card and any subsequent data are ignored.
User Action: Correct code and resubmit.

CBM305A NUMBER OF ANTHROPOMETRIC DIMENSIONS INVALID FOR MEMBER membername.

Reason: The number of anthropometric dimensions specified for the given member on either the +ADD or +CHK control card was either less than one or greater than 45.
System Action: Control card and any subsequent data are ignored.
User Action: Correct value and resubmit.

CBM306A NUMBER OF COMBINATIONS OF INDEPENDENT VARIABLES INVALID FOR MEMBER membername.

Reason: The number of combinations of independent variables (the product of the number of mass related variables and the number of length related variables) for the +ADD or +CHK control card is less than one or greater than 50, for the specified member.

System Action: The control card and any subsequent data are ignored.

User Action: Correct the card and resubmit.

CBM307A NUMBER OF DEPENDENT VARIABLES INVALID FOR MEMBER membername.

Reason: The number of dependent variables specified on the +ADD or +CHK control card was less than one or greater than 30 for the indicated member.

System Action: The control card and any subsequent data are ignored.

User Action: Correct the card and resubmit.

CBM308A NUMBER OF PERCENTILES INVALID FOR MEMBER membername.

Reason: The number of percentiles specified on the +ADD or +CHK control card was less than one or greater than 30 for the indicated member.

System Action: The control card and subsequent data are ignored.

User Action: Correct the number and resubmit.

CBM309A ILLEGAL CONTROL CARD FOR MEMBER membername DUE TO nn ERRORS.

Reason: Control card format invalid. The system found nn errors.

System Action: Control card and subsequent data cards are ignored.

User Action: Correct the card and resubmit.

CBM310A INSUFFICIENT SPACE REMAINING TO ADD MEMBER membername

Reason: The Data Base does not have sufficient continuous space to add the specified member.

System Action: The member is not added to the data base.

User Action: Run the program CBMAM with the +CMP control card, followed by the request to add the specified member. If the CBM310A message reappears, members will have to be deleted (using the +DEL function) before adding new member.

CBM311A DIRECTORY IS FULL, CANNOT ADD membername
Reason: The Data Base directory, which contains the location of each member within the file, can hold a maximum of 20 entries.
System Action: The member is not added to the data base.
User Action: Delete a member and add the new member.

CBM312A MEMBER membername IS NOT FOUND IN THE DIRECTORY
Reason: The type 0 member membername which was referenced by the type 1 member is not in the directory.
System Action: The control card and data are ignored.
User Action: Check that the type 0 member was specified.

CBM313I MEMBER, member name IS TYPE tt AND CONTAINS nn ANTHROPOMETRIC VARIABLE NAMES
Reason: The _ADD or _CHK control card has been read in for the specified member, and the type field and the number of variables have been accepted.
System Action: Program continues execution.
User Action: None.

CBM314I MEMBER ALSO CONTAINS nn ADDITIONAL RECORDS, EACH CONTAINING THE RLEGRESSION COEFFICIENTS FOR mm DEPENDENT VARIABLES
Reason: Message is printed for +ADD or +CHK control card for type 0 members. It provides information on the number of additional records associated with the previously specified member.
System Action: Program continues execution.
User Action: None.

CBM315A VARIABLE variablename1 HAS THE SAME NUMBER AS VARIABLE variablename2
Reason: Each variable entered as part of a type 0 or type 1 member must have a unique number.
System Action: Record which defines variablename1 is flagged as containing an error. Member is not added.
User Action: Correct the number and resubmit.

CBM316A variable name USED IN VARIABLES n1 and n2.

Reason: Each variable name must have a unique variable name.

System Action: Record which contains variable number n2 is flagged as containing an error.

User Action: Correct record and resubmit.

CBM317A variable name IS NEITHER DEPENDENT OR INDEPENDENT.

Reason: An anthropometric variable must be defined as either dependent, that is one necessary for the creation of the link system of the model, or independent, that is a variable highly correlated to body segment length. This variable has not been flagged as either.

System Action: The record is flagged as containing an error, and the member is not added to the data base.

User Action: Punch a "1" in either column 16, 30, or 34, depending on the type of variable and resubmit.

CBM318A variablename IS INDEPENDENT VARIABLE FOR BOTH MASS AND LENGTH.

Reason: An anthropometric variable may be an independent variable correlated to either mass or length, but not to both.

System Action: The record is flagged as containing an error, and the member is not added to the Data Base.

User Action: Delete the entry "1" from either column 26 or 30 and resubmit.

CBM319A MEMBER membername CONTAINS TOO MANY INDEPENDENT VARIABLES.

Reason: The number of combinations of independent variables (number of mass variables x number of length variables) encountered must be equal to the number of combinations specified on the +ADD or +CHK control card.

System Action: Member is not added to Data Base.

User Action: Verify the totals, make the appropriate corrections, and resubmit.

CBM320A MEMBER membername CONTAINS TOO MANY DEPENDENT VARIABLES.

Reason: The number of dependent variables encountered must be equal to the number of dependent variables specified on the +ADD or +CHK control card.

System Action: Member is not added to the Data Base.
User Action: Verify the total, make appropriate corrections, and resubmit.

CBM321A UNIT OF MEASUREMENT, uu FOR VARIABLE variablename IS NOT PERMISSIBLE.

Reason: Valid units of measurement are IN, CM, MM, LB, and KG.

System Action: The record is flagged and the member is not added to the Data Base.

User Action: Supply a valid unit of measurement, and resubmit.

CBM322A DATA CARD IMAGE multiple regression coefficient card image OUT OF SEQUENCE.

Reason: For each combination of independent variables, a total of NDEP+1 records must be supplied, each beginning with the same two variable numbers specifying the mass and length variable.

System Action: The record is flagged and the member is not added to the Data Base.

User Action: Correct the error and resubmit.

CBM323A VARIABLE variablename IS NOT AN INDEPENDENT VARIABLE PERTAINING TO MASS.

Reason: The variable number supplied in column 1-3 of the regression data cards should correspond to a variable name defined as a mass related independent variable on one of the anthropometric variable definition cards.

System Action: The record is flagged and the member is not added to the Data Base.

User Action: Correct the error and resubmit.

CBM324A VARIABLE variablename IS NOT AN INDEPENDENT VARIABLE PERTAINING TO LENGTH.

Reason: The variable number supplied in column 4-6 of the regression definition data cards should correspond to a variable name defined as a length related independent variable on one of the anthropometric variable definition cards.

System Action: The record is flagged and the member is not added to the Data Base.

User Action: Correct the error and resubmit.

CBM325A VARIABLE variablename IS NOT A DEPENDENT VARIABLE.
Reason: The variable number supplied in columns 7-9 of the multiple regression data definition cards should correspond to a variable name defined as a dependent variable on one of the anthropometric variable definition cards.
System Action: The record is flagged and the member is not added to the Data Base.
User Action: Correct the error and resubmit.

CBM326A VARIABLE nn OUT OF SEQUENCE.
Reason: For a type 1 member definition, the survey definition cards must contain the variable numbers in ascending order.
System Action: The record is flagged and the member is not added to the Data Base.
User Action: Make necessary corrections and resubmit.

CBM327A variablename IN MEMBER survey membername DOES NOT CORRESPOND TO VARIABLE nn IN regression membername.
Reason: The variable names and numbers in the type 1 member survey membername should correspond exactly to the names and numbers in the referenced type 0 member regression membername.
System Action: The record in the type 1 member definition is flagged and the member is not added to the Data Base.
User Action: Verify the survey definition variable number and name against the regression or type 0 member, make necessary corrections, and resubmit.

CBM328A ANTHROPOMETRIC DIMENSION LT OR EQ TO ZERO.
Reason: Dimensions supplied in the survey member definition cards must be positive real numbers.
System Action: The record is flagged and the member is not added.
User Action: Correct and resubmit.

CBM329I MEMBER regression membername, WITH nn ANTHROPOMETRIC VARIABLES AND nn₁ X nn₂ SETS OF REGRESSION EQUATION, HAS BEEN ADDED.
Reason: The type 0 member is added to the Data Base.
System Action: The member is added to the Data Base.
User Action: None.

CBM330I MEMBER survey membername, WITH nn ANTHROPOMETRIC
 VARIABLES AND nn₁ PERCENTILES, AND REFERENCING SURVEY
 regression membername HAS BEEN ADDED.
 Reason: The type 1 member is added to the Data
 Base.
 System Action: The member is added to the Data Base.
 User Action: None.

CBM331A membername HAS NOT BEEN ADDED DUE TO nnn ERRORS.
 Reason: After checking the member definition, nnn
 syntax errors were found.
 System Action: The member is not added to the Data Base.
 User Action: Correct the errors, and resubmit.

CBM332A MEMBER membername CHECKED - nnnnn ERRORS.
 Reason: After checking the member definition,
nnnnn synta: errors were found.
 System Action: None.
 User Action: Correct the errors and resubmit.

CBM333I MEMBER membername DELETED.
 Reason: User requested +DEL function caused a
 member to be deleted from the Data Base.
 System Action: Member deleted from Data Base.
 User Action: None.

CBM334I membername NOW IN PLACE.
 Reason: User requested +CMP function caused
 member to be moved within Data Base,
 combining unused space.
 System Action: Directory index in Data Base updated.
 User Action: None.

CBM335I membername WAS IN PLACE.
 Reason: User requested +CMP function and the
 system found that the member membername
 need not be moved.
 System Action: Compression of Data Base continues.
 User Action: None.

CBM336I COMPRESS FINISHED.
 Reason: Successful completion of +CMP function.
 System Action: Program execution continues.
 User Action: None.

CBM337I membername PUNCHED.
 Reason: User initiated +PCH function for member
 membername successfully completed.

System Action: Punching is completed.
User Action: None.

CBM339A END-OF-DATA.

Reason: End of file found before END Program
Control Card (+END) was found.
System Action: Terminates job.
User Action: Use a name and resubmit.

CBM340A MEMBER membername ALREADY EXISTS.

Reason: The user has tried to add an anthropo-
metric member definition under a name
that already exists in the Data Base.
System Action: The control card is ignored.
User Action: Use a new name and resubmit.

CBM341A DATABASE IS NOT AN ANTHROPOMETRIC DATA BASE.

Reason: First record of file does not contain
"ANTH", the Anthropometric Data Base
identification word.
System Action: Terminates the program.
User Action: Contact systems programmer.

CBM342A I/O ERROR ON RECORD nnnnn (INDEX).

Reason: An I/O error has occurred in the direc-
tory of the Anthropometric Data Base.
System Action: Terminates the program.
User Action: Contact systems programmer.

CBM343A I/O ERROR ON RECORD nnnnn (DATA).

Reason: An I/O error has occurred in a member
definition on the Anthropometric Data
Base.
System Action: Terminates the program.
User Action: Contact systems programmer.

CBM399I PROGRAM END.

Reason: The +END Control Card was encountered, or
the end of input cards was encountered,
or there was an I/O error.
System Action: Terminates the program.
User Action: Check that all control cards were
accepted, and processed correctly.

APPENDIX B

COMBIMAN CREW STATIONS

B.1 CREW STATION DESIGN

COMBIMAN crew stations are three-dimensional. The system of programs is set up to accept crew station definitions from any three-dimensional coordinate system. However, the user must provide the three-dimensional COMBIMAN coordinates of the Seat Reference Point (SRP) with respect to the origin of the crew station in the user defined coordinate system. The crew station SRP is defined as the midpoint of the line formed by the intersection of the seat back and the seat pan. The COMBIMAN coordinates of the SRP are $X=0$, $Y=0$, and $Z=0$. The programs convert the input coordinates of the elements of the crew station to the coordinate system of the COMBIMAN.

Since the SRP is a common point of relevance for the man-model and the crew station(s), they can interact and be superimposed on the screen in the correct relationship. Superimposing the man-model and the crew station on the screen is necessary to assess the interactions of the man-model and the crew station.

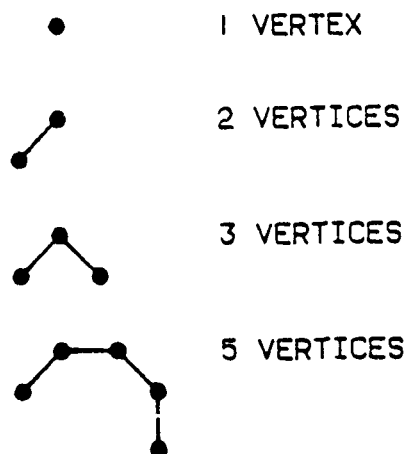
The capability to superimpose crew stations is provided for the convenience of the user. For example, it is not uncommon for a particular type of crew seat to be used in more than one aircraft, or more than one position in multi-operator aircraft. By establishing the seat as an individual member it can be superimposed on crew stations from different aircraft. It can also be moved from one position to another in a multi-operator

crew station. This capability relieves the user from having to duplicate the data coding for different aircraft or seat positions. Another use for this capability can be found in the assessment of flight controls with large or multidirectional movement. The rudder pedal is an example. It is reasonable to expect that a user may need to assess the ability of the man-model to reach a rudder pedal at its nearest, middle and farthest position. By developing three small crew station data bases, one for each of the three rudder pedal positions, they can be individually, or in combination, superimposed on the aircraft crew station.

The crew station is geometrically defined by a series of panels and controls. Panels are segments of the crew station within the programs to generate the display of the crew station. Panels consist of four types: Open, Closed, Seat and Pedal. "Open" panels consist of panels with one or more vertices, with the first and last vertices unconnected. "Closed" panels consist of panels with three or more vertices, with the first and last vertices connected. See Figure B.1 for examples of each. "Seat" is the designation of panels that retain their relative positions when using the Seat Adjust function. "Pedal" is the designation given to the panels making up a rudder/brake pedal display. This designation is required as the program internally uses these data to properly position the foot on the rudder/brake pedal during the Reach and Strength Analysis functions.

Controls define the locations of such items as instruments, knobs, switches, etc. They may be defined relative to their

OPEN PANELS



CLOSED PANELS

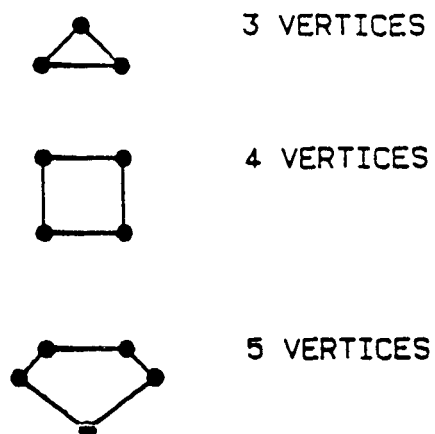


Figure B.1. Examples of Closed and Open Panels

location on a defined panel, or as separate entities by their absolute X, Y and Z coordinates in the user defined coordinate system. Before storing in the Crew Station Data Base, the coordinates are translated and rotated to the COMBIMAN system of coordinates by the program. If the control is located on a defined panel, its coordinates are given relative to a vertex of the panel. In this instance X- and Y-displacement relative to the vertex number specified are entered.

NOTE: The location must be relative to vertices numbered 1 through 9.

B.2 CREW STATION DATA BASE MAINTENANCE PROGRAM (CBMCM2)

The Crew Station Data Base contains definitions which describe the crew stations geometrically. Typical crew stations are aircraft cockpits, driver's area of an automobile, etc. To define a crew station, the user must supply the definition and three-dimensional coordinates of the vertices of the panels which make up the crew station. Each crew station in the data base is called a "member" and is referenced by its membername. There are two Crew Station Data Base members provided with the program as you received it. They are the A7E-01 and the A7--SEAT. The following paragraphs of this appendix provide the necessary instructions for using the utility program CBMCM2 to add members to the Crew Station Data Base.

B.2.1 Processing Capabilities

The program CBMCM2 allows the user to create and maintain the Crew Station Data Base. Input supplied by the user, on 80

character computer cards or in card image format (80 character records) on a magnetic tape or any other device, is read into the program CBMCM2 and is processed according to the control card commands selected by the user. These commands allow the user to add or delete members, to print or punch existing members, or to list the contents of the Data Base and its directory. The program is also used to compress the members within the Data Base.

The control cards for CBMCM2 may be input in any order with one exception. If the Data Base is created for the first time, or if it is reinitialized, the \$INT (Initialize) control card must precede all other control cards and member definitions. The data flow for CBMCM2 is shown in Figure B.2.

B.2.2 Restrictions and Limitations

The Crew Station Data Base may contain up to 20 members. The sum of the record counts for all the members may not exceed 1979 records. Information on the number of members in the Data Base and their size may be obtained by using the \$PRT control card, omitting reference to any membername. Membernames are limited to eight alphanumeric characters. A member definition may contain a maximum of 300 panels and 300 controls. Additional limitations are described in Paragraph B.3.2, "Processing Specifications."

B.3 HOW TO USE PROGRAM CBMCM2

The example used to illustrate this program is based on the crew station in Figure B.3, a seven-drawer desk. In modeling the desk, only the top, front, side, and leg are defined. The other

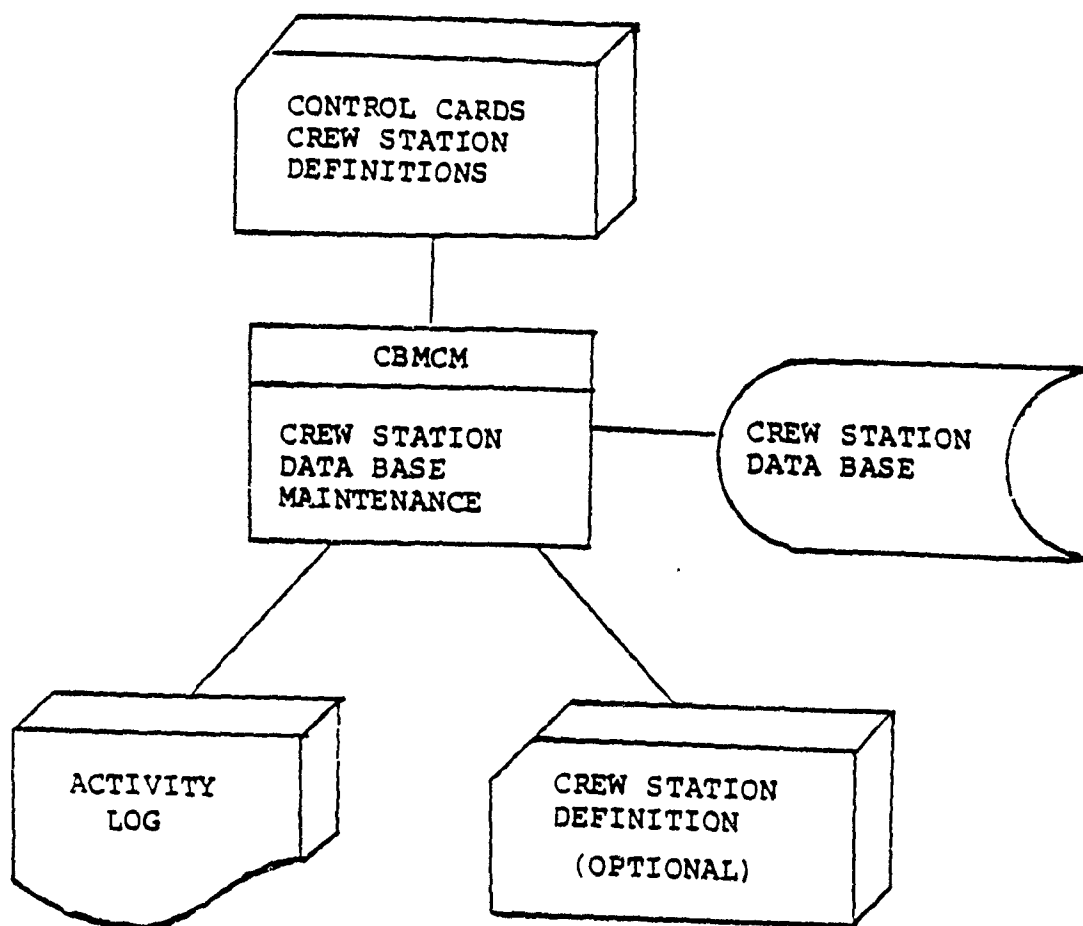


Figure B.2. Data Flow for Program CBMCM2

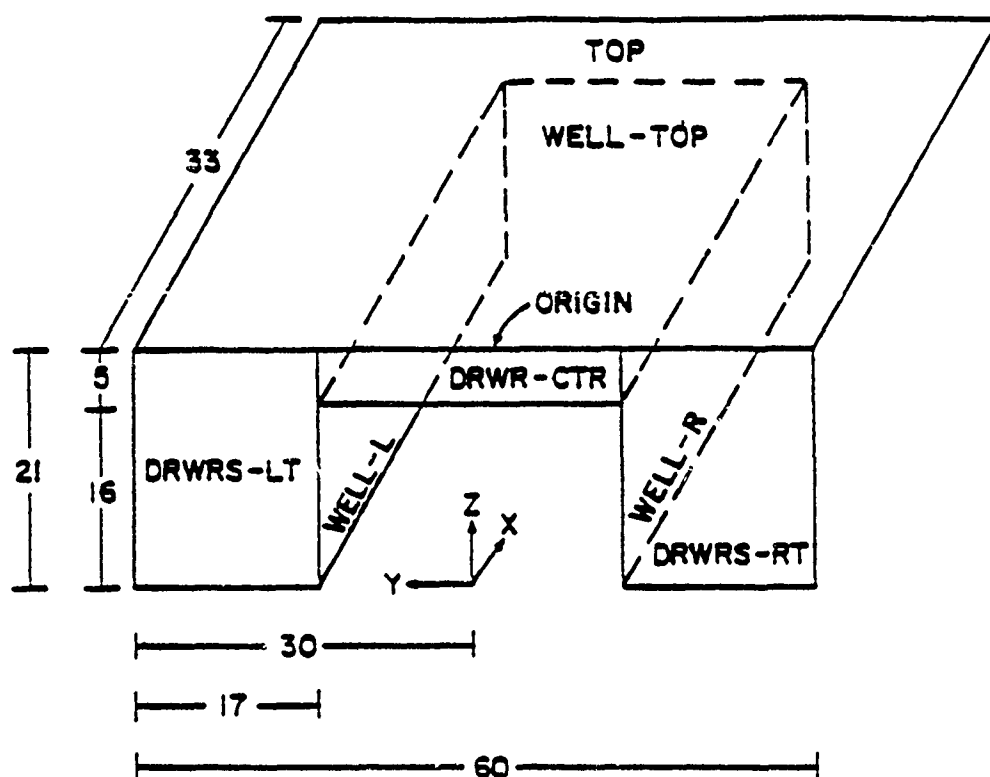


Figure B.3. Sample Crew Station - DESK

sides are not needed because they do not cause any physical or visual interference to the man-model seated at a desk.

B.3.1 Input Data Specification

The program CBMCM2 is set up to accept crew station definitions in any three-dimensional cartesian coordinate system. The coordinate system for COMBIMAN is a right handed system (positive X is forward, positive Y is to the left, and positive Z is up). The user must supply the program CBMCM2 with the three-dimensional coordinates of the Seat Reference Point (SRP) with respect to the origin of the crew station in the user defined coordinate system. From these data, the program converts all input coordinates of the panels and controls to the coordinate system of the COMBIMAN.

The axes of an aircraft coordinate system are perpendicular to each other and basically relate to the Roll, Pitch and Yaw attitudes of the aircraft. Roll being around the Longitudinal axis (Wing Up or Wing down), Pitch being around the Lateral axis (Nose Up or Nose Down), and Yaw being around the Vertical axis (Nose Right or Nose Left). The Longitudinal axis is sometimes referred to as the Water Line, The Lateral axis as the Butt Line, and the Vertical axis as the Fuselage Station Line. Some aircraft coordinate systems, especially those more recently designed, use a three-dimensional X, Y and Z coordinate system.

The designer establishes the location of the origin, which is normally at, or forward of, the nose of the aircraft. The Fuselage Station Line is positive from the origin aft toward the tail of the aircraft. The Butt Line is commonly designated as Butt Line Right and Butt Line Left and is positive in both directions from the origin. The Water Line may be at ground level, or at a designated height above ground level, and is positive from the origin toward the top of the aircraft. When a three-dimensional X, Y and Z coordinate system is used the designer also designates the positive directions of the axes. Prior to the advent of calculators and computers, weight and balance computations were done manually. Establishing the origin at, or forward of, the nose structure and designating Right and Left Butt Lines, to provide all positive values, reduced the opportunity for errors in computations due to using the wrong sign.

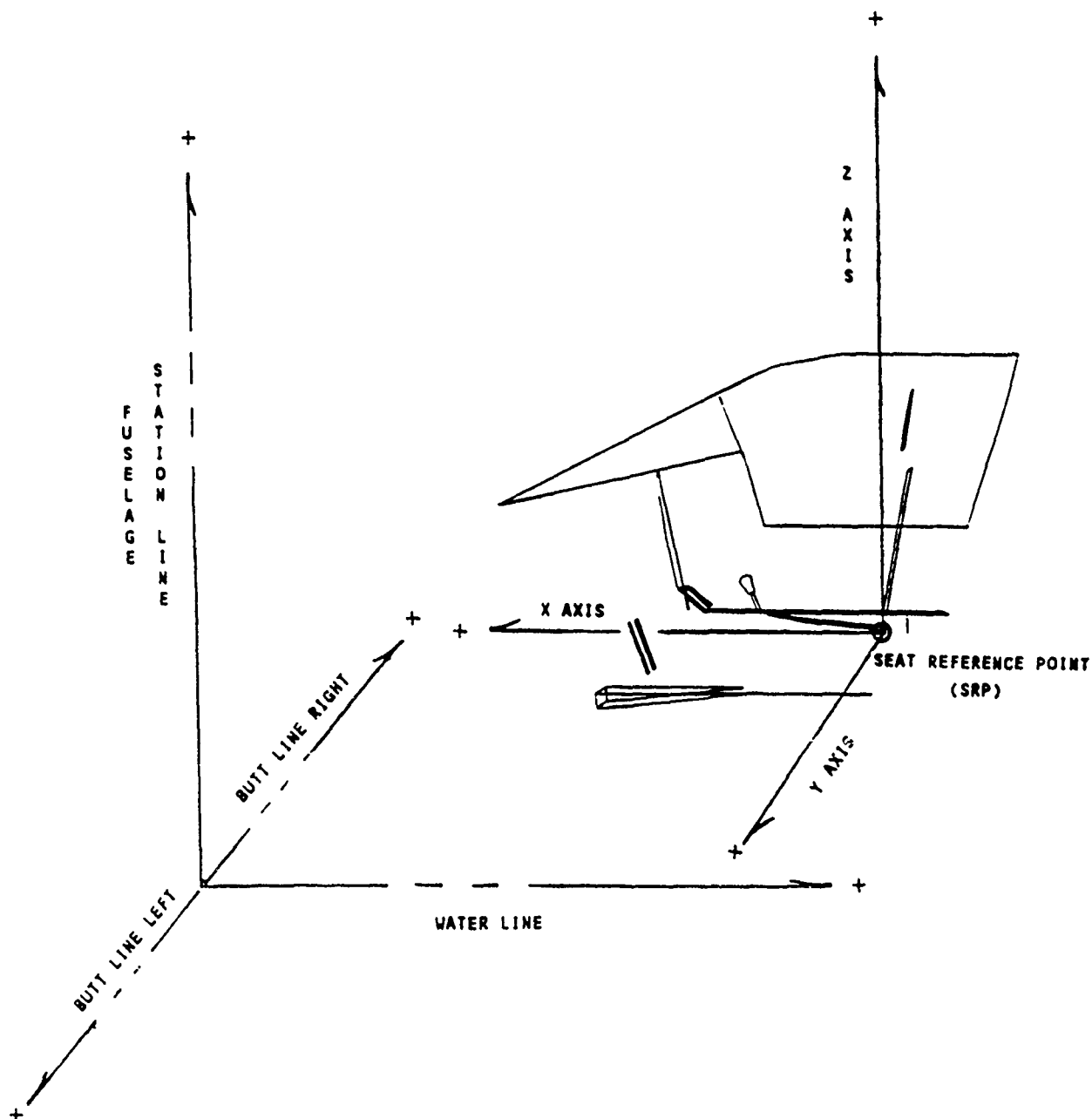
COMBIMAN was developed for analysis of crew stations relative to the seated operator. It was necessary to establish a common origin and coordinate system so the programs could be easily adapted for use with various aircraft crew station designs. Military standards require the definition of the Seat Reference Point (mid-point of the line of intersection between the seat pan and seat back) be established in all military aircraft designs. The Seat Reference Point was selected as the origin for the COMBIMAN coordinate system. A common right hand Cartesian coordinate system (X axis positive direction Forward, toward the nose of the aircraft; Y axis positive direction to the

Left; and Z axis positive direction Up, toward the top of the aircraft) was chosen for COMBIMAN. When the user inputs the positive directions of the aircraft (or other user defined) coordinate system axes and the location of the Seat Reference Point in that coordinate system, the COMBIMAN programs internally convert data to the COMBIMAN coordinate system. Figure B.4 shows an example of a typical Aircraft Coordinate system and its related COMBIMAN Coordinate system.

Using the dimensions of the desk, and the origin as indicated in Figure B.3, three-dimensional coordinates are obtained for the various vertices of the panels. Panels for the crew station have one to twenty-five vertices. Coordinate data for these vertices are entered into the program consecutively, going either clockwise or counterclockwise along the perimeter of the panel. A total of seven panels make up the DESK in the example. Each panel has four vertices, and is rectangular in shape. The coordinates of the vertices are shown in Figures B.5 and B.6.

B.3.2 Processing Specifications

Program CBMCM2 allows the user to maintain the Data Base by adding, deleting, listing, etc. the crew station definitions. The formats to request the functions are shown in Figure B.7. These requests (one request per card) plus the crew station definitions are used as input to the program. The control cards may be input in any order with one exception: when the Data Base is initialized or reinitialized, the \$INT control card must be the



The Location of the SRP in Aircraft Coordinates is:

Fuselage Station	277.17
Butt Line Right	0.01
Water Line	95.35

The Location of the SRP in COMBIMAN Coordinates is:

$X = 0$
 $Y = 0$
 $Z = 0$

Figure B.4. An Example of a Typical Aircraft Coordinate System and Its Related COMBIMAN Coordinate System

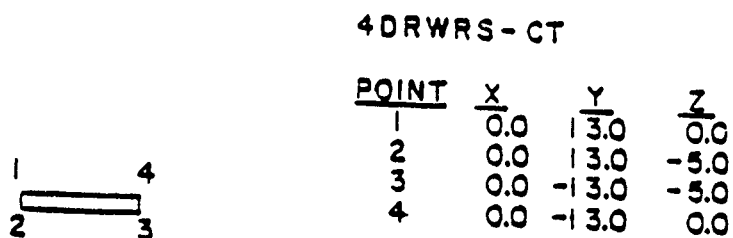
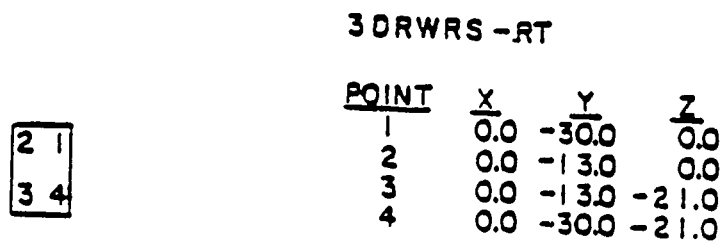
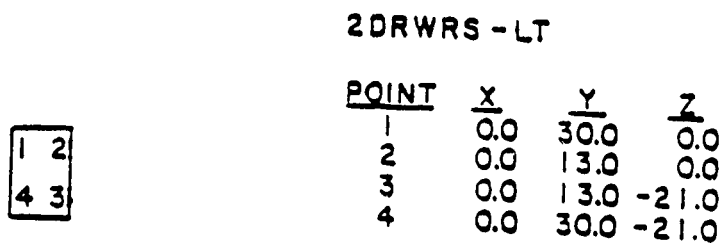
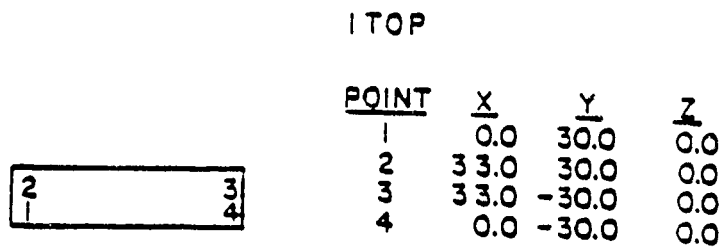


Figure B.5. X, Y, and Z Coordinates of Panels of DESK

1	4
2	3

5WELL - LT

<u>POINT</u>	<u>X</u>	<u>Y</u>	<u>Z</u>
1	0.0	13.0	-5.0
2	0.0	13.0	-21.0
3	33.0	13.0	-21.0
4	33.0	13.0	-5.0

1	4
2	3

6WELL - RT

<u>POINT</u>	<u>X</u>	<u>Y</u>	<u>Z</u>
1	0.0	-13.0	-5.0
2	0.0	-13.0	-21.0
3	33.0	-13.0	-21.0
4	33.0	-13.0	-5.0

2	3
1	4

7WELL - TOP

<u>POINT</u>	<u>X</u>	<u>Y</u>	<u>Z</u>
1	0.0	13.0	-5.0
2	33.0	13.0	-5.0
3	33.0	-13.0	-5.0
4	0.0	-13.0	-5.0

Figure B.6. X, Y and Z Coordinates of Panels of DESK

[illegible]

first input data card. The control card formats are described in the following paragraphs.

B.3.2.1 ADD CREW STATION MEMBER Function

\$ADD membername npnls nctls srpx srpy srpz x y z
(followed by a crew station definition)

The ADD CREW STATION MEMBER function adds the specified data under the name membername of the Crew Station Data Base. The membername is limited to a length of eight characters. The crew station definition contains npnls panels, and nctls controls. These numbers should be entered as integers, right justified in their three digit fields. The Seat Reference Point (SRP) coordinates are srpx, srpy, and srpz and are entered in F6.2 Format. If a decimal point is omitted, CBMCM2 will assume a decimal point between the second and third digits from the right. The directions of the positive x, y, and z coordinate axes are indicated by the characters in the x, y, and z fields respectively. The possible values for x, y, and z are F for Forward, A for Aft, L for Left, R for Right, U for Up, and D for Down. These directions are given with respect to the seated crew member. If the crew station represents a seat, the last four letters of its membername should be "SEAT".

For each panel there is a header card and one to nine coordinate data cards as shown in Figure B.8. The header card has the following format:

Columns 1-3	Sequence number of panel - Integer, right justified.
-------------	--

The first panel entered should have the sequence number "1". Panel numbers do

Figure B.8. Program CBMCM2 ADD Member Card Format for Panels

not require consecutive numbers, but they must be unique.

Columns 4-11	Name of Panel - Eight characters.
Columns 12-14	Panel type - Integer, right justified. "0" or "1" designate "closed" panels. "2" designates "SEAT" panels. "3" designates "pedal" panels. "8" designates "open" panels.

NOTE: If no type code is specified, "1" is assumed.

Columns 15-18	Number of vertices - Integer, right justified (1 to 25). The x, y, and z coordinates of each vertex are entered consecutively, going either clockwise or counterclockwise around the perimeter of the panel.
---------------	---

Each coordinate data card has the following format:

Columns 19-36	x, y, and z coordinates of the first vertex in format 3F6.2.
Columns 37-54	x, y, and z coordinates of second vertex in format 3F6.2.
Columns 55-72	x, y, and z coordinates of third vertex in format 3F6.2.
Columns 73-80	sequence number (optional).

For example, to add a panel with 16 vertices, the user codes one header card and six coordinate data cards. To add a panel with two vertices, the user codes one header card and one coordinate data card.

An example of the input definition for the member "DESK" is shown in Figure B.9. The first outlined area is the \$ADD control card. The second outlined area shows the panel definition cards followed by the control definition cards in outlined area (3).

SADD DESK		7	-15.0 0.0 -11.0 F L U								(1)
1TOP	04	0.0	30.0	0.0	33.0	30.0	0.0	33.0	-30.0	0.0	
0.0 -30.0	0.0										
2DRWRS-LT	04	0.0	30.0	0.0	0.0	13.0	0.0	0.0	13.0	-21.0	
0.0 30.0 -21.0											
3DRWRS-RT	04	0.0	-30.0	0.0	0.0	-13.0	0.0	0.0	-13.0	-21.0	
0.0 -30.0 -21.0											
4DRWRS-CT	04	0.0	13.0	0.0	0.0	13.0	-5.0	0.0	-13.0	-5.0	(2)
0.0 -13.0	0.0										
5WELL-LT	04	0.0	13.0	-5.0	0.0	13.0	-21.0	33.0	13.0	-21.0	
33.0 13.0 -5.0											
6WELL-RT	04	0.0	-13.0	-5.0	0.0	-13.0	-21.0	33.0	-13.0	-21.0	
33.0 -13.0 -5.0											
7WELL-TOP	04	0.0	13.0	-5.0	33.0	13.0	-5.0	33.0	-13.0	-5.0	
0.0 -13.0 -5.0											
L-F-CAMA	0 12	0.0	0.0								
L-S-CAMA	0 11	0.0	0.0								
R-F-CAMA	0 13	0.0	0.0								
R-S-CAMA	0 14	0.0	0.0								(3)
DRWACTNA	0 42	0.0	-13.0								
DRWRLB	0 00	-1.0	22.0	-19.0							
DRWRLC	0 00	-1.0	22.0	-13.0							
DRWRLT	0 00	-1.0	22.0	-7.0							

Figure B.9. Sample Data for \$ADD Member Function

The card for defining a control is in the following format
(Figure B.10)

Columns	1-8	Control name - eight characters
Columns	9-14	Control type (not currently used)
Columns	15-17	Panel number [pnl#]
Column	18	Vertex number (1 through 9) [v#]
Columns	19-36	Control location
	19-24	X coordinate
	25-30	Y coordinate
	31-36	Z coordinate (blank if located relative to a defined panel number)

If the program detects an error in the input data for a member, the member will not be added to the Data Base.

B.3.2.2 CHECK CREW STATION MEMBER Function

\$CHK membername npnls nctls srpx srpy srpz x y z
(followed by a crew station definition).

The CHECK CREW STATION MEMBER function operates in the same way the ADD CREW STATION MEMBER function does, EXCEPT that the member is not added. This function checks new member input data for proper format and content.

B.3.2.3 DELETE CREW STATION MEMBER Function

\$DEL membername

The DELETE CREW STATION MEMBER function removes the specified crew station member from the Data Base, but does NOT make the space occupied by the member available for reuse. In

\$	opr	member name	no. pnl: I3	no. ctls: I3	Seat Reference Point 3F6.2						x	y	z															Optional Sequence Number																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
A1	A3	A8	I3	I3				x	y	z																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											</

Figure B.10. Program CBMCM2 ADD Member Card Format for Controls

order to make the space available to add more crew stations, the COMPRESS CREW STATION DATA BASE function must be used.

B.3.2.4 COMPRESS CREW STATION DATA BASE Function

\$CMP

The COMPRESS CREW STATION DATA BASE function compresses used space together, maximizing the amount of continuous unused space. The intermediate blocks of unused space are created by the DELETE CREW STATION MEMBER function. When the message "CBM127A NO SPACE, CANNOT ADD membername" appears while adding a crew station it is necessary to use this function. If the \$ADD function gives the CBM127A message immediately after the \$CMP function, the Data Base is full.

B.3.2.5 DUMP CREW STATION MEMBER Function

\$DMP membername
\$DMP

The DUMP CREW STATION MEMBER function prints the contents of the crew station member membername, or prints the complete Crew Station Data Base if member name is omitted on the control card. The format of the display is:

RECORD nn	+	=	+	(record in EBCDIC		+	=	+
	+	=	+	(record in hexadecimal)		+	=	+
	+	=	+	(rest of record in hexadecimal)		+	=	+

The + = + characters act as delimiters of the displayed data. This function is used primarily by system programmers to test the file.

B.3.2.6 END PROGRAM Function

\$END

The END PROGRAM function terminates execution of the program CBMCM2.

B.3.2.7 INITIALIZE CREW STATION DATA BASE Function

\$INT

The INITIALIZE CREW STATION DATA BASE function resets the Data Base to the original unused state. The primary purpose of this function is to establish a Crew Station Data Base.

B.3.2.8 PUNCH CREW STATION MEMBER Function

\$PCH membername

The PUNCH CREW STATION MEMBER function punches a copy of the specified member in a format that the ADD CREW STATION MEMBER function requires. Specifying a membername that does not exist on the directory will result in a printout of all the membernames on the Data Base.

B.3.2.9 PRINT CREW STATION MEMBER Function

\$PRT membername
\$PRT

The PRINT CREW STATION MEMBER function prints the contents of the specified member, membername, in a format similar to that of the ADD CREW STATION MEMBER function. Specifying no name, or a nonexistent name, causes a printout of the index containing membernames, their record locations on the Data Base, and the origin and orientation of their coordinate systems.

B.3.3 Executing CBMCM2 Program

The sequence of JOB CONTROL LANGUAGE (JCL) cards needed to execute the program CBMCM2 is shown in Figure B.11. All function control cards and member definition cards follow the "//SYSIN DD*" card. The "//FT01F001" DD card included in this sequence assumes that the space for the Data Base has already been allocated on disk. If the Data Base does not exist, the "//FT01F001" DD card specified in Figure B.11 should be replaced by the sequence of cards shown in Figure B.12. This sequence to allocate space for the Data Base and to initialize it should be executed only once. Thereafter, the simplified "//FT01F001" DD card shown in Figure B.11 should be used for all file manipulations.

Once the Data Base is allocated on Disk, it must be initialized using \$INT function before using any other function. For every CBMCM2 job, the last function control card read into the program should be the "\$END" card.

//CBMCM	JOB HESS	00001000
//JOB LIB	DD DSN=COMBIMAN.LOADLIB,DISP=SHR	00001100
//CBMCM	EXEC PGM=CMBCM	00001200
//FT01F001	DD DSN=COMBIMAN.CRSTDATA,DISP=SHR	00001300
//FT05F001	DD DDNAME=SYSIN	00001400
//FT06F001	DD SYSOUT=A	00001500
//FT07F001	DD SYSOUT=B	00001600
//SYSDUMP	DD SYSOUT=A	00001700
//SYSIN	DD *	00001800

CBMCM2 FUNCTION CONTROL CARDS AND
MEMBER DEFINITION DATA

Figure B.11. Job Control Cards to Execute Program CBMCM2

//FT01F001	DD DSN=COMBIMAN.CRSTDATA,UNIT=DISK,DISP=(NEW,CATLG),	00001300
//	VOL=SER=DISK01,SPACE=(368,2000)	00001310
//	DCU=(BLKSIZE=368,LRECL=368,RECFM=FB)	00001320

Figure B.12. FT01 DD Card to Allocate Space on Disk and
Execute Program CBMCM2

B.3.4 Output Data Interpretation

The program CBMCM2 generates output to the card punch, disk file, or printer, depending on the specified control card function. The formats for the printed output will be discussed in this section. Punched records have the same format as the input data records discussed in Paragraph B.3.2. The physical format of the records on the Data Base is not described here.

Five basic formats are used by CBMCM2 for printed output. These format types, their use, and their examples are presented in this subsection. All types begin with the same heading "CBMCM2", the date and time of the program execution, and page number.

The first type of output is generated by the INITIALIZE, PUNCH, COMPRESS, DELETE, and END functions. The output indicates the start and end of processing associated with the specified function. For the COMPRESS function additional messages indicating that a particular member is, or is not, moved in the process of combining unused space is also printed. An example of this format, for the Compress function, is shown in Figure B.13.

The second type of output is generated by the PRINT or PUNCH functions when the \$PRT or \$PCH control card is supplied with blank membername field. This causes the index of the Data Base to be printed in the following format:

```
nn.) membername, EXTENT=(n1, n2), np PANELS, nc CONTROLS,  
      ORIGIN=(xx, yy, zz), ORIENT=(a, b, c)
```

where:

```

CUM1001 SCMP
CUM1201 IAC1      WAS IN PLACE.
CUM1201 A/E      WAS IN PLACE.
CUM1201 A7       WAS IN PLACE.
CUM1201 FMC1     WAS IN PLACE.
CUM1201 A7-01    WAS IN PLACE.
CUM1201 A/E-01   WAS IN PLACE.
CUM1291 H1-CIAIR NOW IN PLACE.
CUM1291 H1-NAV01 NOW IN PLACE.
CUM1291 H1-NAV1A NOW IN PLACE.
CUM1291 H1-NAV2A NOW IN PLACE.
CUM1291 SALN     NOW IN PLACE.
CUM1291 SACL     NOW IN PLACE.
CUM1291 IX SK    NOW IN PLACE.
CUM1301 COMPRESS FINISHED.

```

Figure B.13. A Sample Output of the Compress (\$CMP) Function

<u>nn</u>	is the number of the member identification record within the directory
<u>membername</u>	is the name of the member identified
<u>n1</u>	is the location of the first record which defines this member
<u>n2</u>	is the location of the last record which defines this member
<u>np</u>	is the number of panels associated with this member
<u>nc</u>	is the number of controls associated with this member
<u>xx</u>	is the location of the seat reference point with respect to the origin of the coordinate system of the crew station
<u>yy</u>	
<u>zz</u>	
<u>a</u>	is the orientation of the positive x-axis of the crew station
<u>b</u>	is the orientation of the positive y-axis of the crew station
<u>c</u>	is the orientation of the positive z-axis of the crew station

An example of the PRINT function is shown in Figure B.14.

The third type of output is generated by the DUMP function. This function is intended to be used primarily by system programmers to locate the cause of I/O (Input/Output) errors on the Data Base. For the member specified on the \$DMP control card, a message giving directory or index information is printed using the second output format described elsewhere. Each data record associated with the member is printed in the following format:

RECORD nn	+	=	+	(recorded in EBCDIC)	+	=	+
	+	=	+	(record in hexadecimal)	+	=	+
	+	=	+	(remainder of record in hexadecimal)	+	=	+

MEMBERNAME	SPRT	PRINT	MEMBERNAME	FUNCTION
9-1 SACR	EXEMPT-0	204	1 CONTROLS	1 CONTROLS
10-1 SACR	EXEMPT-0	804	1 CONTROLS	1 CONTROLS
11-1 MI-MAY20	EXEMPT-0	756	1 CONTROLS	1 CONTROLS
12-1 MI-L-MAR	EXEMPT-0	404	1 CONTROLS	1 CONTROLS
13-1 MI-MAY10	EXEMPT-0	724	1 CONTROLS	1 CONTROLS
14-1 MI-MAY01	EXEMPT-0	494	1 CONTROLS	1 CONTROLS
15-1 AIE-01	EXEMPT-0	392	1 CONTROLS	1 CONTROLS
16-1 AIE-01	EXEMPT-0	404	1 CONTROLS	1 CONTROLS
17-1 AIE	EXEMPT-0	350	1 CONTROLS	1 CONTROLS
18-1 F-M-L	EXEMPT-0	461	1 CONTROLS	1 CONTROLS
19-1 AIE	EXEMPT-0	45	1 CONTROLS	1 CONTROLS
20-1 HALL	EXEMPT-0	220	1 CONTROLS	1 CONTROLS
21-1 DESK	EXEMPT-0	030	1 CONTROLS	1 CONTROLS

Figure B.14. A Sample Output of the Print (\$PRT) [No Membername] Function

where nn is the location of the record within the Data Base. The record in EBCDIC is printed using a 25A4 format. The record in hexadecimal is printed using a 10Z8 format. An example of the output for the DUMP function is shown in Figure B.15.

The fourth output format is used by the CHECK and ADD functions. After reading the control card and checking it for errors, the information contained on the card is printed first.

The panel definition cards, after being read and checked for errors, are printed in the following format:

```
nn.) pnl_nm, TYPE=tt, nv VERTICES--INPUT COORD-- -- ABSOLUTE
COORD --
  (xx1 , yy1 , zz1 ) , (ax1 , ay1 , az1 )
      .
      .
      .
  (xxi , yyi , zzi ) , (axi , ayi , azi )
      .
      .
      .
  (xxnv , yynv , zznv) (axnv , aynv , aznv )
```

where:

<u>nn</u>	is the panel number
<u>pnl_nm</u>	is the panel name
<u>tt</u>	is the panel type
<u>nv</u>	is the number of vertices used to define the panel
xx _i , yy _i , zz _i	are the x, y, and z coordinates for the ith vertex of the panel, in the crew station system of coordinates, where i=1, nv.

ax_i , ay_i , az_i are the x, y, and z coordinates of the ith vertex of the panel, converted to the COMBIMAN system of coordinates, where i=1, nv.

After all the panel definition data are printed, CBMCM2 prints the control data using the following format:

cntl_nm tt pnl_ref. v.# (xx,yy,zz) TO (ax,ay,ax) & (rx,ry)

where:

<u>cntl_nm</u>	is the 8 character name of the control
<u>tt</u>	is the 2 digit control type (not currently used)
<u>pnl_ref</u>	is the panel where the control is located (if applicable)
<u>v.#</u>	is the reference vertex number for that control (if applicable)
<u>xx</u> <u>yy</u> <u>zz</u>	are the three-dimensional coordinates (relative or absolute) which define the location of the control
<u>ax</u> <u>ay</u> <u>az</u>	are the three-dimensional coordinates which define the location of the control in the COMBIMAN system of coordinates
<u>rx</u> <u>ry</u>	are the two-dimensional relative coordinates of the control. If the control is not defined relative to a panel, rx=ry=0.0.

An example of this fourth output format for the \$ADD function is shown in Figure B.16.

The fifth and last format is similar to that used for the ADD function input, and is used for the PRINT function when a valid membername is specified. The main difference between this format and the fourth is that this format does not print the original input data used to add the member to the Data Base.

After printing the index record for the member, the program
CBMCM2 prints the panel definition data in the following format:

```

nn.) pnl nm, TYPE=tt, nv VERTICES--ABSOLUTE COORDINATES--
      (xx1 , yy1 , zz1 )
      .
      .
      .
      (xxi , yyi , zzi )
      .
      .
      .
      (xxnv , yynv , zznv )

```

where:

<u>nn</u>	is the panel number
<u>pnl nm</u>	is the 8-character name of the panel
<u>tt</u>	is the panel type
<u>nv</u>	is the number of vertices which define the panel
<u>xx</u> _i , <u>yy</u> _i , <u>zz</u> _i	are the x, y, and z coordinates of the i th vertex of the panel, in the COMBIMAN system of coordinates, where i=1, nv.

After printing the panel definition data, the program prints
the control data using the following format:

```

cntl nm tt pnl ref v# (ax, ay, az) (rx, ry)

```

where:

<u>cntl nm</u>	is the 8 character name of the control
<u>tt</u>	is the 2 digit control type
<u>pnl ref</u>	is the panel on which the control is located (if applicable)
<u>v#</u>	is the reference vertex number of the panel for that control (if applicable)

<u>ax</u>	are the three-dimensional coordinates
<u>ay</u>	which define the control in the COMBIMAN
<u>az</u>	system of coordinates
<u>rx</u>	are the two-dimensional relative
<u>ry</u>	coordinates of the control. If the
	control was not defined relative to a
	panel, rx=ry=0.0.

An example of the output for the \$PRT function using the fifth format is shown in Figure B.17.

B.4 PROGRAM MESSAGES - INCLUDING ERROR CORRECTION

The program CBMCM2 prints both information and action related messages. The message format is as follows:

<u>CBM1nni</u>	<u>message text</u>
----------------	---------------------

where:

<u>nn</u>	is the message number
<u>i</u>	indicates the action code (I=Informational, A=Action to be performed), and
<u>message text</u>	is the text of the message.

Unless otherwise noted, all messages are generated by the routine CBMCM2.

The messages are as follows:

CBM100I control card image

Reason:	User submitted a control card.
System Action:	Continues processing.
User Action:	None.

CBM101A operation UNKNOWN OPERATION.

Reason:	The operation on the control card shown in the previous CBM100I message is unknown.
System Action:	Ignores this control card.
User Action:	Correct the card and resubmit.

- CBM102A panelnumber INVALID PANEL NUMBER FOR POINT controlname
Reason: The panel number specified by the control definition card does not exist.
System Action: Assumes that the control is defined in absolute coordinates.
User Action: Delete the crew station member, correct the card, and resubmit.
- CBM103A vertexnumber INVALID VERTEX NUMBER FOR POINT controlname
Reason: The panel in which the control is defined does not have vertex vertexnumber.
System Action: Uses vertex number 1.
User Action: Delete the crew station member, correct the error, and resubmit.
- CBM104A Z NOT ZERO, PANEL & VERTEX NOW ZERO FOR POINT controlname
Reason: A panel number and a vertex number are specified, but the Z value is not zero.
System Action: Makes Z zero and continues processing.
User Action: If setting Z equal to zero corrects the problem, no action needed. Otherwise, delete the crew station member, correct the data card and resubmit.
- CBM105A NO NAME GIVEN, operation IGNORED
Reason: This operation requires a crew station member name, but no name is specified.
System Action: Ignores the operation.
User Action: Supply the member name and resubmit.
- CBM106A membername NOT FOUND
Reason: For the DELETE, DUMP, PUNCH or PRINT function, the specified crew station member name does not exist.
System Action: Prints the Crew Station Data Base directory.
User Action: Correct the error and resubmit.
- CBM107A NUMBER OF PANELS/CONTROLS INVALID FOR MEMBER membername
Reason: The number of panels or controls as specified on the ADD function control card (\$ADD) is either less than 1 or greater than 300.
System Action: Ignores the control card.
User Action: If the number as specified is less than 1, correct and resubmit. If the number as specified is greater than 300, split the crew station definition into two units and add them separately.

CBM108A DIRECTION FOR X INVALID, MEMBER IS membername
Reason: During the ADD function (\$ADD), the direction of the user's X-axis is not F, A, L, R, U or D.
System Action: Ignores the control card.
User Action: Correct the control card and resubmit.

CBM109A DIRECTION FOR Y INVALID, MEMBER IS membername
Reason: During the ADD function (\$ADD), the direction of the user's Y-axis is not F, A, L, R, U or D.
System Action: Ignores the control card.
User Action: Correct the control card and resubmit.

CBM110A DIRECTION FOR Z INVALID, MEMBER IS membername
Reason: During the ADD function (\$ADD), the direction of the user's Z-axis is not F, A, L, R, U or D.
System Action: Ignores the control card.
User Action: Correct the control card and resubmit.

CBM111A X&Y, X&Z OR Y&Z ARE COLLINEAR FOR MEMBER membername
Reason: The directions of two or more of the user's axes are the same (ex. X=L, Y=U, & Z=U or X=L, Y=U & Z=L).
System Action: Ignores the control card.
User Action: Pick unique directions for the axes and resubmit.

CBM112A DIRECTORY IS FULL, CANNOT ADD membername
Reason: No space is available in the Crew Station Data Base directory to add an entry for this member.
System Action: Ignores the control card.
User Action: Delete a member and resubmit.

CBM113A PANEL IS ZERO, BUT POINT IS NOT FOR membername
Reason: In defining a control, either the panel number and the vertex number must be zero, or both numbers must be non-zero. Note that blank entry is converted to zero.
System Action: Takes the control definition as absolute.
User Action: Delete the crew station, correct the error and resubmit.

CBM114A membername ALREADY EXISTS

Reason: User tried to add a crew station definition under a name that already exists on the Data Base.
System Action: Ignores the control card.
User Action: Use a new name, and resubmit.

CBM115A END OF DATA.

Reason: The end of file was found before the END Program control card (\$END).
System Action: Terminates the program.
User Action: Check to make sure that all the control cards are processed.

CBM116A I/O ERROR ON RECORD recordnumber (INDEX)

Reason: An I/O error occurred on the Crew Station Data Base.
System Action: Terminates the program.
User Action: Contact systems programmer.

CBM117A I/O ERROR ON RECORD recordnumber (DATA)

Reason: An I/O error occurred on the Crew Station Data Base.
System Action: Terminates the program.
User Action: Contact systems programmer.

CBM119A NEW MEMBER, membername, HAS nn PANELS AND nn CONTROLS

Reason: The user added a crew station definition to the Data Base.
System Action: The new crew station is added to the Data Base.
User Action: None.

CBM120I COORDINATES ARE TRANSLATED TO seat reference point coordinate

Reason: The user added a crew station definition to the Data Base.
System Action: The addition is accepted.
User Action: None.

CBM121I COORDINATES GIVEN AS axis, axis AND axis ARE NOW R, F, AND U.

Reason: The user added a crew station definition to the Data Base.
System Action: The addition is accepted.
User Action: None.

CBM122I PROGRAM END

Reason: The End Program function control card (\$END) or the end of the file card is encountered, or there is an I/O error.
System Action: Terminates the program.
User Action: Check to make sure that all control cards are accepted, and processed correctly.

CBM123I membername DELETED

Reason: The user submitted a delete Crew Station Definition function control (\$DEL).
System Action: Makes the requested deletion.
User Action: None.

CBM124I INITIALIZED

Reason: The user requested that the Crew Station Data Base be initialized.
System Action: The Data Base is initialized.
User Action: None.

CBM125A Number of vertices IS AN INVALID NUMBER OF VERTICES FOR panel name

Reason: To define a control, the user specified the control in a panel not found in this crew station.
System Action: Assumes that the control is defined absolutely.
User Action: Make sure that the panel is defined. Correct and resubmit.

CBM126I membername PUNCHED

Reason: The user requested that member membername be punched on cards.
System Action: Punches the data.
User Action: None.

CBM127A NO SPACE, CANNOT ADD membername

Reason: There is not enough space in the data base to hold the requested addition.
System Action: Ignores the control card.
User Action: Compress the Data Base and resubmit.

CBM128I membername WAS IN PLACE

Reason: The user requested that the Data Base be compressed. The member, membername, was already compressed and not moved.
System Action: The name member was not moved.
User Action: None.

CBM129I membername NOW IN PLACE

Reason: The user requested that the Data Base be compressed. The member, membername was not in place, and therefore has been moved to facilitate compression.

System Action: The member is moved to another location in the Data Base.

User Action: None.

CBM130A panelname USED IN PANELS panelnumber₁ AND panelnumber₂

Reason: In the crew station member definition, two panels have the same name. The number of these panels are panelnumber₁ and panelnumber₂.

System Action: Both panels are accepted in spite of the duplicate names.

User Action: Delete the definition, change one of the names, and resubmit.

CBM131A panelname HAS SAME PANEL NUMBER AS panelnumber

Reason: In the crew station definition, two panels have the same panel number.

System Action: Both panels are accepted. Note that references to the second will cause a reference to the first.

User Action: Delete the crew station definition, correct the error, and resubmit.

CBM132A controlname IS A DUPLICATE NAME

Reason: In adding a crew station definition, two controls have the same name.

System Action: Only the first control can be referenced.

User Action: Delete the definition, change one of the names to make it unique, and resubmit.

APPENDIX C

COMBIMAN VISION LIMIT OVERLAY DATA BASE MAINTENANCE PROGRAM (CBMODM)

The VISION LIMIT OVERLAY DATA BASE is used by the VISIBILITY ANALYSIS function (PFK 6). This function displays the rectilinear projection of the crew station from the eye location of the current man-model, the three-dimensional coordinates of the selected crew station, and vision limit overlays stored in the VISION LIMIT OVERLAY DATA BASE.

The field surrounded by a "vision limit overlay" is the total field of vision relative to the head. The field of peripheral vision is what COMBIMAN can see with no restrictive head gear. If head gear is added which limits vision, the field becomes smaller. If the user has data describing a restriction to vision, a new overlay can be constructed and added to the data base using the procedure in this section. Up to 15 members can reside in the data base and be selected for display in the overlay menu when PFK 6 is selected. By using the CBMODM program to change or create the VISION LIMIT OVERLAY DATA BASE the user can create plots for different types of protective head gear.

C.1 PROCESSING CAPABILITIES

The program CBMODM allows the user to create and change the VISION LIMIT OVERLAY Data Base. Input data are supplied on 80-character computer cards, card images on magnetic tape, or direct access device, and are processed according to the user's selection of control commands. These commands allow the user to

add or delete members, to print information about existing members, or to list contents of the Data Base.

The control cards may be input in any order with one exception: when the Data Base is created for the first time or is re-initialized, the \$INT (initialize) control card must precede all other control cards and member definitions.

C.2 RESTRICTIONS AND LIMITATIONS

A maximum of 15 overlay members may reside in the VISION LIMIT OVERLAY DATA BASE. Each member may contain up to 100 points made up of X and Y coordinates.

C.3 HOW TO USE CBMODM

A fictitious vision limit overlay is used to illustrate data collection and data transformation for the ADD Member function (Paragraph C.3.2.1) of the CBMODM program. The data collected for a vision limit overlay can be in many forms. The following sections give two common ways data could be collected and transformed for input to ADD Member function.

C.3.1 Input Data Specification

Data describing a restriction to vision would be collected with a peripheral vision testing device. There are a variety of commercial and non-commercial devices available. Figure C.1 and C.2 describe two devices commonly used to measure field of vision limits.

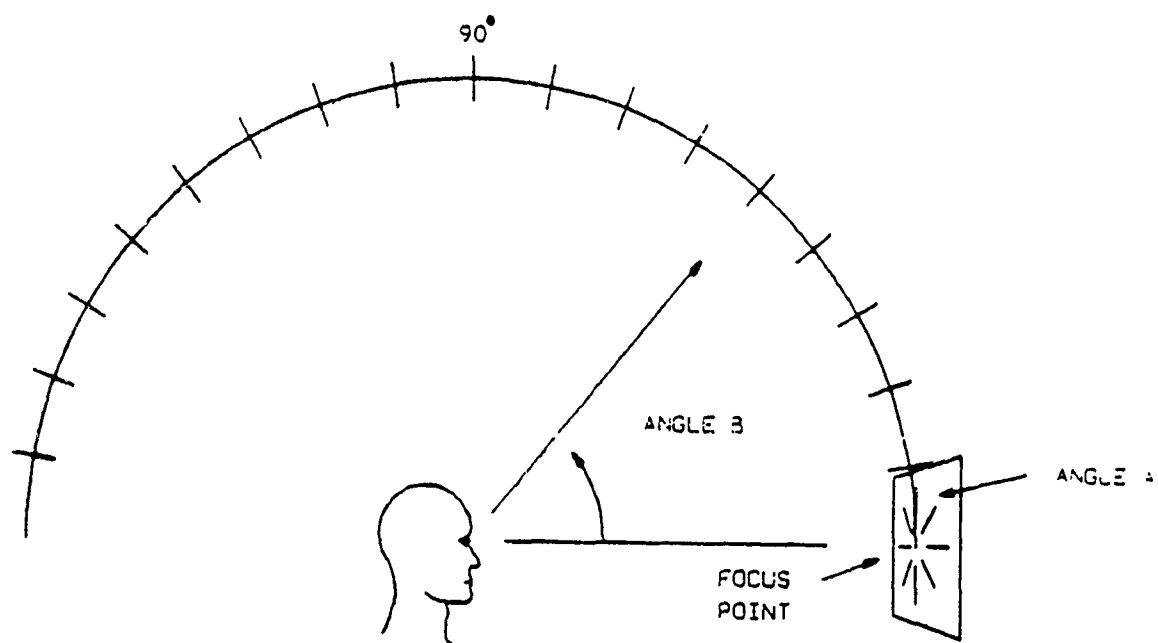


Figure C.1. Device 1: Subject Faces the Horizontal Pivot of a Semicircular Protractor Which Pivots About the Longitude Axis. Data describe (first) the angle of the protractor plane (Angle A) and (second) the angle of vision limit in that plane (Angle B).

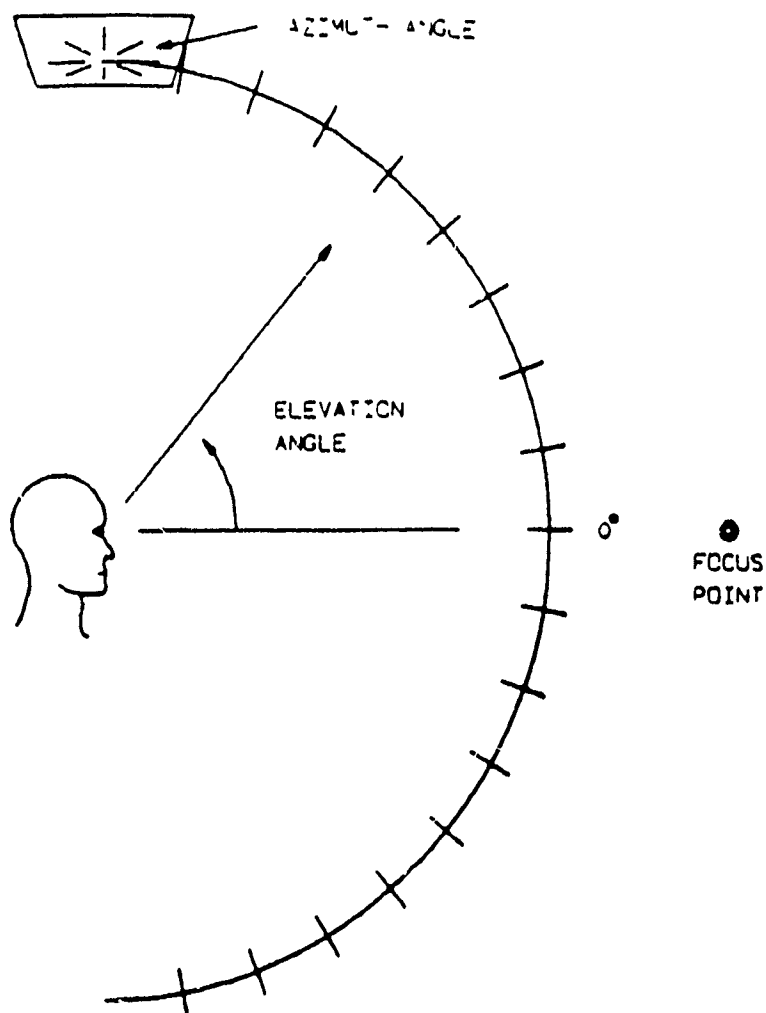


Figure C.2. Device 2: Subjects Sit Beneath the Vertical Pivot of a Semicircular Protractor. Data describe (first) the azimuth angle (left or right of forward) and the elevation angle (above or below horizontal). This azimuth/elevation data can be entered directly into the data base without transformation.

The data collected from the device shown in Figure C.2 are in azimuth/elevation angles and can be entered directly into the data base. The data collected from the device in Figure C.1 need to be converted into azimuth/elevation angles. The device in Figure C.1 will give two angles, the angle of the protractor plane (A) arm and the angle from forward (B). The angle of the protractor plane is between 0 and 360 degrees, and the angle from forward is between 0 and 180 degrees. An example of the data collected for a fictitious vision limit overlay is shown in Figure C.3 where angle A is the angle of the protractor plane and angle B is the vision limit angle for forward. The data have to be converted to Azimuth and Elevation angles for input for the ADD MEMBER function. The following equations will convert the spherical angles to rectangular (azimuth, elevation) angles:

$$\text{Elevation angle} = \sin^{-1} (\sin A \sin B)$$

$$\text{Azimuth angle} = \cos^{-1} (\cos B / \cos (\sin^{-1} (\sin A \sin B)))$$

A - angle of the protractor plane.

B - angle from forward.

NOTE: The azimuth angle should be given a positive sign for points to the right of forward; negative if left of forward. If the vision limits are symmetrical (they usually are) only the points at the center and right of center need be converted. The points to the left can be obtained by changing the sign of the azimuth angle.

Figure C.4 shows the transformed data. Once the data are transformed the ADD MEMBER function can be used to add a new member to the VISION LIMIT OVERLAY DATA BASE.

ANGLE A	ANGLE B
0	90
45	70
90	60
135	70
180	90
225	70
270	30
315	70

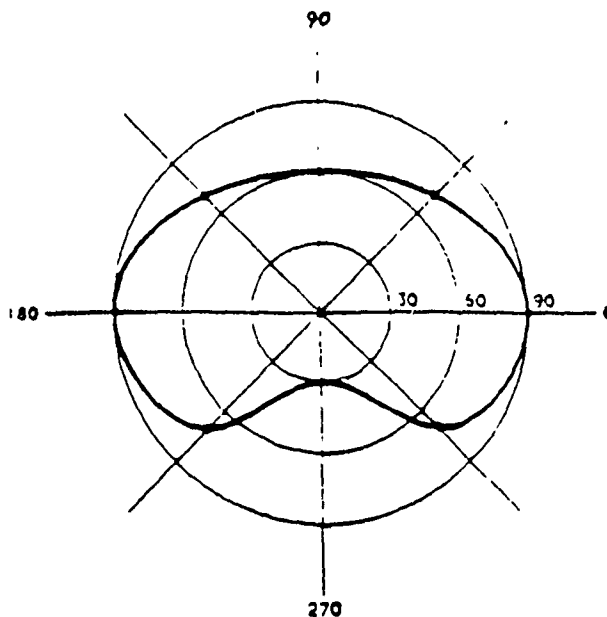


Figure C.3. Data Collected in Spherical Angles. These data must be converted to azimuth/elevation angles before they can be entered into the data base.

AZIMUTH	ELEVATION
90	0
63	42
0	60
-63	42
-90	0
-63	-42
0	-30
63	-42

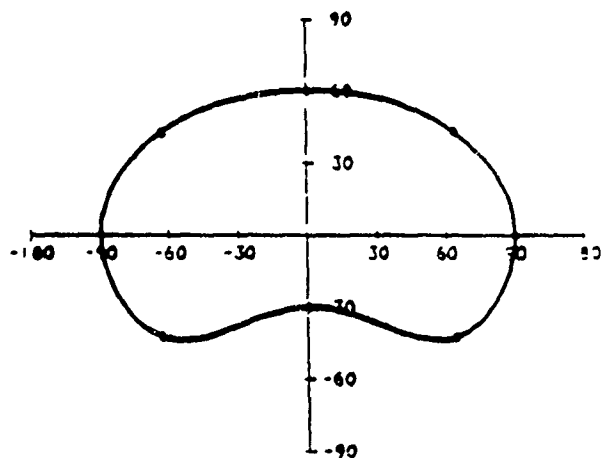


Figure C.4. Data Transformed to Azimuth/Elevation Angles.

The VISION LIMIT OVERLAY DATA BASE Maintenance Program scales the azimuth/elevation coordinate pairs so that they may be superimposed on the visibility plots. A smooth curve will be generated to fit the points provided. It is recommended that no fewer than eight coordinate pairs be used. Although 100 pairs may be entered, increasing the set beyond 36 pairs does not cause a significant difference in the shape of the vision envelope.

C.3.2 Processing Specification

The available functions are requested using control cards with the format described in Figure C.5. The control cards are explained in the following paragraphs.

C.3.2.1 ADD OVERLAY MEMBER Function \$ADD membername

The ADD OVERLAY MEMBER function adds the input data under the member name membername to the VISION LIMIT OVERLAY DATA BASE. The membername is limited to a length of 20 characters. The number of pairs is the number of coordinate pairs (X,Y) in the overlay. This value can range between 4 and 100, but a minimum of 8 is recommended. The input format of an add control card is shown in Figure C.5. The coordinate pairs (X,Y) are in degrees.

X coordinate point = azimuth angle

Y coordinate point = elevation angle

Azimuth angles left of forward are negative; right, positive. Elevation angles above horizontal are positive; below, negative. The coordinate pairs are formatted by entering X coordinate point and Y coordinate point on the same card. The format

A1	A3	1X	A20	1X	I3
\$	OPR		Member Name		Number of Pairs

Figure C.5. Program CBMODM Control Card Format.

for entering the data is shown in Figure C.6. The data for creating the EXAMPLE OVERLAY member are shown in Figure C.7 and the output that will be produced from the ADD function is shown in Figure C.8.

If the program detects an error in the input data the member will not be added to the Data Base.

C.3.2.2 CHECK OVERLAY MEMBER Function

\$CHK membername

The CHECK OVERLAY MEMBER function operates in the same way the ADD OVERLAY MEMBER function does except that the member is not added, but is only checked for errors.

C.3.2.3 DELETE OVERLAY MEMBER Function

\$DEL membername

The DELETE OVERLAY MEMBER function removes a given membername from the Data Base.

C.3.2.4 DUMP OVERLAY MEMBER Function

\$DMP

The DUMP OVERLAY MEMBER function prints the contents of VISION OVERLAY DATA BASE.

C.3.2.5 PRINT OVERLAY MEMBER Function

\$PRT membername or
\$PRT

The PRINT OVERLAY MEMBER function prints the data contained in the specified membername in a format similar to the input to the ADD OVERLAY MEMBER function. Specifying no name or a

F7.1	3X	F7.1	3X
Azimuth Angle (X)		Elevation Angle (Y)	

Figure C.6. Program CBMODM Data Card Format.

```

$ADD EXAMPLE OVERLAY      008
  90.0      0.0
  63.0      42.0
   0.0      60.0
 -63.0      42.0
 -90.0      0.0
 -63.0     -42.0
   0.0     -30.0
  63.0     -42.0
$END

```

First Area - Control Card.

Second Area - Data Points.

Figure C.7. Sample Data for \$ADD MEMBER Function.

```

CBM700I $ADD EXAMPLE OVERLAY
CBM710I $ADD  NAME :EXAMPLE OVERLAY      NUMBER OF POINTS =  8

X COORDINATE POINTS      Y COORDINATE POINTS
  90.0      0.0
  63.0      42.0
   0.0      60.0
 -63.0      42.0
 -90.0      0.0
 -63.0     -42.0
   0.0     -30.0
  63.0     -42.0

```

Figure C.8. Sample Output for \$ADD MEMBER Function.

nonexistent name causes a printout of the list of members names in the directory.

C.3.2.6 INITIALIZE OVERLAY DATA BASE Function \$INT

The INITIALIZE OVERLAY MEMBER function is used primarily to establish a Data Base, although it may be used to return the data base to its original unused state.

C.3.2.7 END PROGRAM Function \$END

The END PROGRAM function terminates execution of the program CBMODM.

C.3.3 Executing CBMODM Program

The sequence of Job Control Language (JCL) cards needed to execute the program CBMODM is shown in Figure C.9. Initialization of the Data Base for the first time requires allocation of space on disk for the Data Base and is accomplished by the "//FT09F001 DD" cards shown in Figure C.10 and the \$INT control card initializes the Data Base. The "//FT01F001 DD" card in Figure C.9 is used for all subsequent processing requests. The &END control card is always the last control card and it ends the program CBMODM.

```

//CBMODM    JOB HESS
/*
//JOB LIB   DD   DSN=COMBIMAN.LOADLIB,DISP=SHR
//CBMODM    EXEC PGM=CBMODM
/*
//SYSPRINT DD   SYSOUT=A
//FT01F001 DD   DSN=COMBIMAN.OVERLAY.BASE,DISP=SHR
//FT05F001 DD   DSN=SYSIN
//FT06F001 DD   SYSOUT=A
//SYSIN     DD   *

CBMODM FUNCTION CONTROL CARDS AND
MEMBER DEFINITION DATA

/*
//

```

Figure C.9. Job Control Cards to Execute CBMODM.

```

//FT01F001 DD   DSN=COMBIMAN.OVERLAY.BASE.DISP=(NEW,CATLG,DELETE) ,
//              SPACE=(800.16).UNIT=SYSDA

```

Figure C.10. FT01001 DD Card to Allocate Space for COMBIMAN.OVERLAY.FILE.

C.4 PROGRAM MESSAGES - INCLUDING ERROR CORRECTION

The program CBMODM prints out information and action related messages. The message format is:

CBM7nni message text

where:

i indicates the action code (I=Informational,
A=Action to be performed)

nn is the message number

message text is the text of the message.

CBM700I control card image

Reason: User has submitted a control card.
System Action: Reads the control card.
User Action: None.

CBM701A operation UNKNOWN OPERATION.

Reason: The operation on the control card (shown
in the previous CBM500I message) is
unknown.
System Action: This control card is ignored.
User Action: Correct the card and resubmit.

CBM702A NO NAME GIVEN, operation IGNORED.

Reason: This operation requires a member name, but
none was supplied.
System Action: The operation is ignored.
User Action: Supply the member name and resubmit.

CBM703A NUMBER OF DATA POINTS IS NOT WITHIN RANGE.

Reason: The number of data points is less than 4
or greater than 100.
System Action: The member will not be added to Data Base.
User Action: Either reduce or increase number of data
points.

CBM706A DIRECTORY IS FULL, CANNOT ADD membername.

Reason: No space is left in the VISION OVERLAY
Data Base directory to add an entry for
this member. The directory can hold only
15 membernames.

System Action: The control card is ignored.
User Action: Delete one or more members, compress the Data Base, and resubmit.

CBM707A membername ALREADY EXISTS.

Reason: User has tried to add a member definition under a name that exists in the Data Base.
System Action: The control card is ignored.
User Action: Use a new name, and resubmit.

CBM708I MEMBER membername CHECKED, nn ERRORS.

Reason: During \$CHK, the system found nn errors.
System Action: Reads next control card.
User Action: Correct and resubmit.

CBM709I membername NOT ADDED DUE TO nn ERRORS.

Reason: During \$ADD operation, the system found nn errors.
System Action: Reads next control card; member is not added.
User Action: Correct error(s) and resubmit.

CBM710I Add membername with n points.

Reason: Information on add operator.
System Action: Program continues.
User Action: None.

CBM711A membername NOT FOUND.

Reason: For the Delete function (\$DEL) or Print function (\$PRT) the specified visibility member name does not exist.
System Action: The directory of the visibility data base is printed, instead of performing the requested function.
User Action: Check the control card for nonexistent membername.

CBM712I membername DELETED.

Reason: The user submitted a DELETE function control card (\$DEL).
System Action: The membername is deleted.
User Action: None.

CBM713I INITIALIZED.

Reason: The user requested that the Visibility Data Base be initialized using the INITIALIZE VISIBILITY DATA BASE Function (\$INT).

System Action: The Data Base is initialized.
User Action: None.

CBM714I PROGRAM END.

Reason: The END PROGRAM function control (\$END) card was executed.
System Action: Terminates program.
User Action: Make sure that all control cards are accepted, and processed correctly.

CBM715A DATA BASE IS NOT VISIBILITY DATA BASE.

Reason: First record in directory contains a keyword 'OVER' to identify a Visibility Data Base. We accessed a data set without that keyword.
System Action: Terminates program.
User Action: Check JCL cards and access correct data set.

CBM716A END OF DATA.

Reason: The end of file was found before the END Program control card (\$END).
System Action: The program is ended.
User Action: Check to make sure that all the control cards are processed.

CBM717A I/O ERROR ON RECORD recordnumber (INDEX).

Reason: An I/O error occurred on the Visibility Data Base.
System Action: Terminates the program.
User Action: Contact Systems Programmer.

CBM718A I/O ERROR ON RECORD recordnumber (DATA).

Reason: An I/O error occurred on the Visibility Data Base.
System Action: Terminates the program.
User Action: Contact Systems Programmer.

CBM719I PROGRAM ABENDED.

Reason: Program could not recover from an error.
System Action: Terminates the program.
User Action: None.

APPENDIX D

OFF-LINE PLOT PROGRAM (CBMOFF)

CBMOFF is an off-line plot program which plots COMBIMAN data displayed on the IBM 2250 screen. When the user needs a plot which cannot be done On-Line¹, the OFF-LINE PLOT COMBIMAN function (PFK 7) is depressed to store the man-model and crew station data of the display currently on the CRT (see Paragraph 6.1). The user may store as many sets of these data as needed on data set unit 11. Program CBMOFF plots these data using Calcomp compatible software. The user specifies the data sets to be plotted, as well as plot size, color, and content.

The following information is intended as a programmer's guide to use the program CBMOFF.

D.1 PROCESSING CAPABILITIES

The user specifies the contents and size of the plot as well as its color. This is done by providing the following two input cards along with the plot data file.

- (1) the NAMELIST/CNTRL/, and
- (2) a card with the plot numbers of those data sets not to be plotted.

The information supplied on these cards allows the user to vary plot size, plot color, and plot content as follows:

- (1) The NAMELIST/CNTRL/'s variables and their default values:

¹At WPAFB AAMRL we use a 22" Model Versatec electrostatic plot for On-Line plots and a 4-color Calcomp 1012 plotter for report quality output and quarter-scale Off-Line plots.

FACTR - When specified, FACTR is the plot scale factor for that program run, otherwise, the scale factor specified for each plot during the COMBIMAN run when the data were generated (see Paragraph 6.1) is used.

IPLINK, IPFLES, and IPWKSP - These three variables allow user to eliminate the link system, the enfleshment, and/or the crew station respectively from plots for that program run. Specifying IPLINK, IPFLES and/or IPWKSP equal to "1" deletes that element(s) from the plots. Using the default values

IPLINK=0

IPFLES=0, and

IPWKSP=0

all elements on the CRT display are plotted.

ICBANN, ICLINK, ICFLES, ICWKSP determines the pen color for elements of the plot where,

ICBANN is the plot banner,

ICLINK is the link system,

ICFLES is the enfleshment, and
ICWKSP is the crew station.

The default² values of the pen colors for plot banner, link system, enfleshment and crew station are:

ICBANN=1 for banner,

ICLINK=1 for link system,

ICFLES=2 for enfleshment, and

ICWKSP=3 for crew station.

The format of the Namelist CNTRL is as follows (Figure D.1):

column 1	- a blank
column 2	- a & ³
columns 3-7	- the word CNTRL
column 8	- a blank

After column 8 comes none, all, or any combination of the keyword control variables in the form FLESH=1, FACTR=.95, ICLINK=3,..., the last one followed by a "&END" indicating the end of the NAMELIST variable input. NOTE: This data card must appear.

- (2) The second data card contains the plot numbers of the data to be skipped. The format for the data card is shown in Figure D.2. The data card can contain up to twenty plot numbers, each right-justified integer in one of the 3-character fields in the first sixty columns of the card. These numbers can be in any order and do not need to fill consecutive fields. If the card is left blank, no plot will be skipped.

Figure D.3 shows an Off-Line plot of the man-model and a crew station, as it appears on the CRT, and the plot banner (Figure D.4) indicates that the plot is a perspective plot with scale factor 0.85. The data card input for this plot is shown in Figure D.5. Notice that all values except IPFLES and IPWKSP remain at their default values in the NAMELIST/CNTRL/. This implies that the scale factor for the plot is the one specified during the COMBIMAN run when the plot data were generated. The link system, enfleshment, and crew station as displayed on the CRT are included in the plot. Since both ICFLES and ICWKSP are set equal to 1 in the input, all elements of the plot will be of

²When an off-line plot is made, the user specifies the color assignments.

³ The & symbol is used while executing the program on an IBM computer: other computers may have different symbols for this purpose.

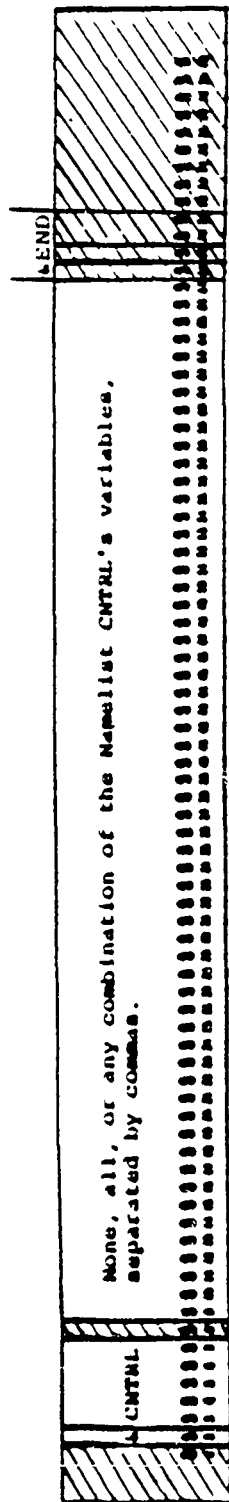


Figure D.1. The Format of the Namelist CNTRL

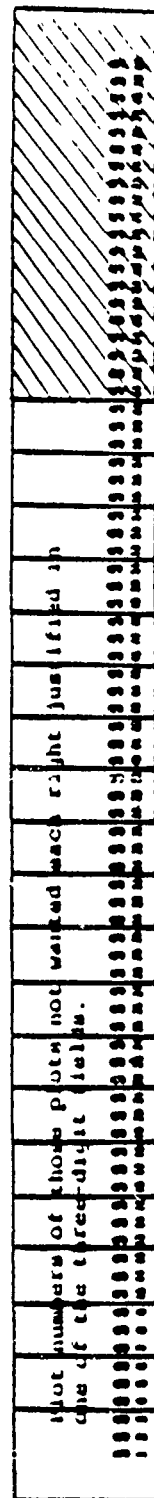


Figure D.2. The Format of the Data Card for Unwanted Plots

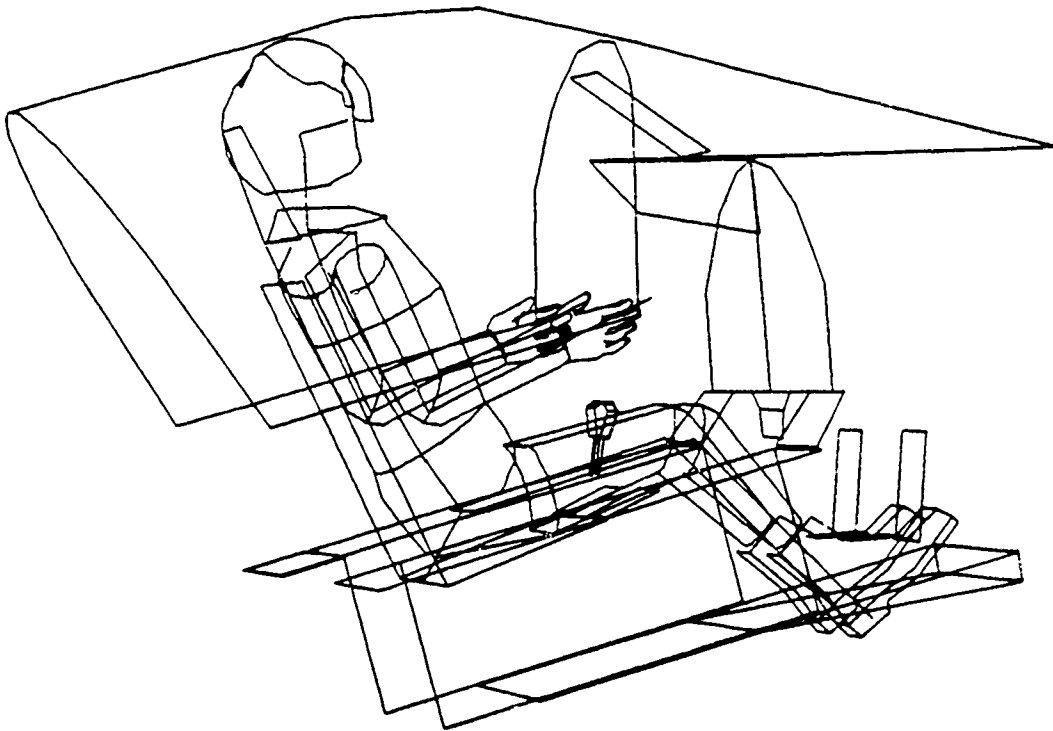


Figure D.3. COMBIMAN OFF-LINE Plot

SURVEY:67 USAF CREWSTATION:A7--SEAT DATE: 11/ 8/85
VIEW-PLANE: OFF AXIS ROLL:0.0 PITCH:-15.0 YAW:15.0
PERSPECTIVE PLOT SCALE:0.85
PLOT NUMBER: 2

Figure D.4. Plot Banner

the same color (in this case black). Also notice that the second input card contains a "1" in column six denoting that plot number 1 is to be skipped. The plot shown in Figure D.3 is plot number "2" as indicated in Figure D.4.

Figure D.6 shows the input cards used to generate Figure D.7 from the same plot data. FACTR=0.55 resets the plot scale factor to 0.55 of the original plot scale factor. IPFLES=1 deletes all enfleshment from the man-model, and the color of all plot elements is again black.

D.2 PROGRAM MESSAGES - INFORMATION AND ERROR TYPE

The program CBMOFF prints both information and action related messages. The message format is as follows:

CBM2nni message text
where

CBM	identifies the message and indicates that the message originates from COMBIMAN system
2	identifies the message and indicates that the message originates from the program CBMOFF
<u>nn</u>	is the message number
<u>i</u>	identifies the action code (I = Informational, A = Action to be performed), and
<u>message text</u>	is the text of the message.

CBM201I PLOT SET plotnumber WAS NOT PLOTTED -- BY REQUEST.
Reason: User requested that plot plotnumber not be plotted.
System Action: Plot plotnumber is not plotted.
User Action: None.

SURVEY: 67 USAF CREWSTATION: A7--SEAT DATE: 11/ 8/85
VIEW-PLANE: OFF AXIS ROLL: 0.0 PITCH: -15.0 YAW: 15.0
PERSPECTIVE PLOT SCALE: 0.47
PLOT NUMBER: 2

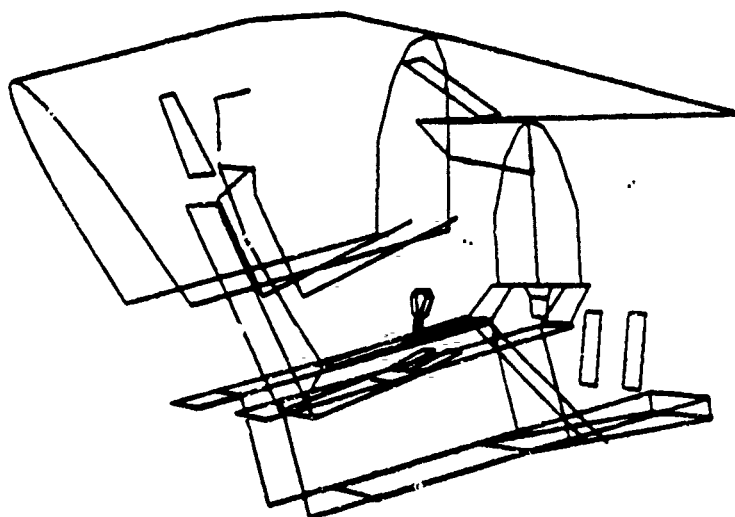


Figure D.7. Altered COMBIMAN OFF-LINE Plot

CBM202A INCORRECT AMOUNT OF DATA FOR PLOT plotnumber -- PROGRAM
ENDING.

Reason: There was too much or too little data on
file for plot plotnumber.

System Action: No plotting occurs, and program ends.

User Action: Recreate plot file.

CBM203I SCALE FACTOR CHANGED FROM 1 TO factor2

Reason: User input a value for FACTR (factor2) in
the namelist CNTRL.

System Action: Factor2 is used to scale the plot.

User Action: None.

APPENDIX E

CADAM TO COMBIMAN CONVERSION PROGRAM CADCBM)

COMBIMAN can also be used to analyze three-dimensional drawings developed using the advanced design capabilities of the computer-aided design (CAD) package CADAM. Any three-dimensional drawing contained in the CADAM drawing data base can be transferred into the COMBIMAN crew station data base by using a simple, three step procedure.

STEP 1:

The drawing to be transferred must first be oriented so that the COMBIMAN coordinate system lies parallel to the drawing coordinate axes. The COMBIMAN coordinate system uses the Seat Reference Point (SRP) as the origin, ($X=0$, $Y=0$, $Z=0$) and is defined as the mid-point of the line of intersection of the seat back and seat pan. The positive X axis direction is forward from the seat back toward the front of the seat pan. The positive Y direction is to the left from the SRP and parallel to the line of intersection. The positive Z axis direction is up from the seat pan. In addition, the design should be translated so that the seat reference point of the design corresponds to the origin of the CADAM drawing.

Reorientation and translation of the design can be performed using the capabilities found under CADAM's function key /GROUP/ (see the CADAM Procedures Manual). Once the reorientation and translation has been performed, the CADAM drawing must be filed.

STEP 2:

Once the design has been oriented, translated, and filed, you must execute the program CADCBM, which converts the drawing into a format which can be used as input for the COMBIMAN crew station data base maintenance program, CBMCM2.

The JCL for executing CADCBM can be found in COMBIMAN.CNTL(CADCBM). This is a generic JCL file, and must be customized to run on your system *see your system programmer). The input file for CADCBM defines the drawing names to be processed, and the CADAM subgroup in which each drawing is contained *Figure E.1). This file is in card-image format, and is defined by the FT09F001 DD card. The CADAM subgroup and drawing name is stored on each record, respectively, using a format of (2A4,5X,5A4). The output from the CADCBM program is defined the FT12F001 DD card, and is also in card-image format.

Only three-dimensional, geometrical elements (lines, splines, circles, and ellipses) are converted by CADCBM; non-geometric elements, such as notes or dimensions, and two-dimensional elements are ignored. In addition, elements which are irrelevant to the human factors analysis of the crew station need not be converted, and can be excluded from conversion by using CADAM's /NO SHO/ under function key /SHOW/.

STEP 3:

The final step in the conversion process requires the execution of the COMBIMAN crew station data base maintenance program CBMCM2. The input for this program was created in the data set defined by the FT12F001 DD card in Step 2. See Appendix B for further details on how to execute CBMCM2.


```

      .
      .
      .
//FT09F001 DD *
TRAIN      PANEL LAYOUT      1
TRAIN      A7E-01
TRAIN      VISIBILITY        DEMO
/*
      .
      .
      .

```

Figure E.1. Sample Control File for CADCBM

The name of the crew station created by the three steps above is determined by the first eight characters of the drawing name. Thus consideration must be given to the drawing name, in order to avoid duplicating existing crew station names.